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## THE ELECTRICAL PROPERTIES OF THE ATMOSPHERE.

In the study of the electrical properties of the air considerable advance has been made during recent years, but we are still sadly ignorant of the behavior of this element. The subject is interesting not only from the scientific point of view, but to engineers, who are looking forward to a decided increase in the voltage of transmission systems, whereby they hope to decrease the cost of construction and at the same time increase the area over which power may be economically distributed.

For a great deal of our knowledge regarding this ever-present mixture of gases we are indebted to Dr. J. J. Thomson, and we have come to expect from time to time further additions by him to this. In a recent lecture before the Royal Institution, of London, he discussed the conduction of electricity through gases, but limited his remarks to one method by which this is brought about; the method, he said, which is so inconspicuous under ordinary conditions that for many years it was not recognized at all. This is the conduction brought about by ionization of the air, itself caused, it is believed, by radioactive substances.

The seemingly erratic behavior of air when employed as a conductor of electricity has been one of the most puzzling electrical phenomena, but this, it is now believed, is fully explained by the recognition of the presence of radium emanation in the air, which brings about a degree of ionization depending upon the quantity of the emanation present, and, hence causes the air to act as a conductor in the same proportion.

Another interesting question is to explain how the earth manages to maintain its negative charge if it is surrounded by a conducting atmosphere. The potential gradient in the air is fairly large and may indeed be as much as one volt per centimetre, which would indicate that the negative charge should be neutralized rapidly by the positive electricity of the air. The fact that this neutralization is going on continuously has been established by C. T. R. Wilson, who found that the rate of neutralization is sufficient to discharge the earth in an hour if the negative charge were not being continuously given back to the earth. How this is done has not yet been explained, but Dr. Thomson thinks that rain plays a large part in it, if it is not, in fact, the sole agent. Drops of water form more easily on negatively charged particles. Rain may be thought of, then, as forming on the negatively charged dust particles, and as it falls to the earth it not only clears the air, but restores to the earth its negative charge.

One of the most surprising features of modern scientific

advance is the new light it is shedding on forces and actions which are continuously playing around us, but of which we have had no intimation before. One can but wonder what influences they must exert on every phase of terrestrial life and development.

## SUBDIVIDING ARC-CIRCUIT DISTRIBUTION.

The size of wire used for all important series arc distribution outdoors is almost always no smaller than No. 6 Brown & Sharpe gauge, for mechanical reasons. The carrying capacity of this wire for currents under ten amperes enables circuits to be extended to any length consistent with operating convenience, with no danger that the line drop will be excessive. On account of the capacity of this size of wire, the practice has become almost universal of running the entire arc service of a city from one station, bringing all the circuits into a single group of switchboard panels, and controlling the output from this central point.

It is undoubtedly a considerable convenience thus to focus the control of the lamps operating in a score or two square miles of territory, and unless more than one generating plant or substation is necessary in the general scheme of central-station distribution in a city, it is probable that the single-station plan of arc-circuit distribution will prove the most economical where only a few hundred lamps are involved. As the number of arc lamps and the area of distribution increase, however, it becomes more and more important to figure carefully the economy of subdividing the arc-circuit control. If the matter is examined closely in connection with future work there is little doubt that there will be more of the subdivided method practiced in the future.

In the case of one city served by 3,150 alternating-current, 7.8-ampere, series arc lamps, the control of the street-lighting circuits was subdivided, with excellent results in the matter of operating and investment economy. The alternating-current service of this town is supplied by 6,600-volt, three-phase circuits, distributing high-tension current from a central generating plant to four substations located at various strategic points in the business and residential districts. These substations are on the average not over three miles apart, and are not more than two and one-half to three miles from the main generating station, generally considered. From the substations direct-current railway service is supplied to the local street-car system by motor-generators, and a certain amount of 2,300-volt constant-potential lighting and power work is also handled by one or more of the substations, although the main station takes care of a large 2,300-volt commercial load. The transmission distances are, of course, short, but the loads are fairly heavy and the voltage regulation is admirable. To secure economy in the arc-circuit distribution, two of the substations have been equipped with constant-current transformers at present handling 600 lamps at each substation. A third carries 750 lamps, and a fourth, 1,200. The original plan of distributing the arc circuits was from the central station, and this required the running of a trunk-line pole service carrying 250 wires. By the new arrangement of distributing from the substations the saving in cost of copper and pole-line space far more than offsets the cost of substation building necessary to house the two transformers, switchboard panels and arc-circuit wiring, and there was an additional saving in space at the main generating station, which was somewhat handicapped for the necessary expansion of a rapidly growing system. It has been found that the saving in pole-line maintenance pays three times over for the cost of operating the arcs from the local substation. Attendance is necessary at these points for the railway service, but only a small share of this labor belongs to the arc operation.

In general, with a large number of arc circuits necessary, a very attractive showing in copper economy can be effected by transmitting even at 2,300 volts over a trunk line to the substation, and running the local No. 6 arc wires shorter average distances in distributing from the latter. The showing may be still more favorable when the transmission potential rises to 6,600, 13,200 volts, or upward. Whether it will pay to build single arc distributing substations with the incurred attendance in systems where there is no railway service must be figured on its merits in each case. There appears to be little trouble in operating local arc lines with automatic regulation from substations, and it is highly desirable to estimate the cost of installing and operating by subdivision in cases where a large number of circuits and many hundreds of lamps are required.

## ELECTRIC PROPULSION OF SHIPS.

The proposal to interpose the electric motor between the prime movers and propellers of vessels has been discussed at various times, though usually upon general considerations. At a recent meeting of the Institution of Engineers and Shipbuilders, of Scotland, Mr. Henry A. Mavor took up this subject in a more definite way and endeavored to show that the advantages which might be secured through the introduction of this intermediate gearing would probably make the system economical as well as convenient. The prime object of the electrical system is to make it possible to combine the advantages of the compact high-speed steam turbines and the large slow-speed propellers. The former is the most economical steam consumer; and the latter the most efficient propelling device.

The systems which have heretofore been proposed have made use of the direct-current motor because of the advantageous properties of this device as regards starting and speed variation. But the large slow-speed motors which are necessary for direct-connection to low-speed propellers running at 150 revolutions a minute, or thereabouts, are not particularly easy machines to design. Mr. Mavor, it seems, has also some prejudice against commutators on such large motors, and he proposes that this latter objection be avoided by the use of alternating-current motors. Such a plan either involves some sacrifices of starting ability and speed variation or requires a more or less complicated alternating-current motor. It is true, however, that

vessels employed on long voyages stop and start seldom, and a large number of possible running speeds is not necessary. A rheostatic control of an induction motor would be satisfactory for most conditions, but it would, of course, be inefficient for steaming at low speeds during prolonged thick weather. The latter condition could be met by winding the motor stator so as to enable the rotor to run at lower speeds. This would be a simple and pretty solution of the problem, provided it did not increase the size of the motor too greatly. But these methods are not considered by Mr. Mavor, who proposes mounting the stator of his induction motor on bearings so that it, also, may be allowed to revolve. The vessel may be started then by bringing what would normally be the stator up to full speed, the rotor revolving but slowly. Then by gradually braking the primary element it could be brought to a standstill while the rotor would be brought up to full speed. This would give excellent starting properties and the losses due to braking the primary element would be of small moment, since they would be taking place but a short time only. This system could, of course, be used to vary the speed, but would be uneconomical, as the loss would be directly proportional to the speed of the primary element. At half speed the efficiency would be less than fifty per cent.

To meet this objection it is suggested that the primary element of the motor might be constructed to act also as the secondary element of a second primary. The motor would then consist of three parts: A stator proper, which would be the true primary; an intermediate rotor acting as secondary to the stator and as primary to the element coupled directly to the propeller shaft. Such a system would give two or more economical speeds, according to the character of the winding, and intermediate speeds by applying a brake to the intermediate rotor. This, of course, would involve a loss of energy directly proportional to the speed of that part. Moreover, the double motor would itself be less efficient than a simpler one, since it involves a double transformation, each, of course, giving rise to some loss. It is a question whether, in the end, this system would be any more efficient or less complicated than a pure direct-current system.

Neglecting, however, this phase of the question, it is interesting to note the way in which the electric system is better than the direct-connected engine. A simple propeller shaft has an efficiency of probably not less than ninety-five per cent, while the double transformation involved in the use of a dynamo and motor would hardly give an efficiency of more than eighty-eight per cent under normal conditions. But the use of a direct-connected engine compels the employment of a fairly high-speed propeller, the efficiency of which may be as low as forty-five per cent. By adopting the electric drive, the most desirable type of propeller may be chosen and an efficiency as high as seventy per cent secured, which not only offsets the greater loss of the electric transmission, but compensates for the increased cost of the system as compared with the simple engine drive. This would enable the vessel to enjoy to the full the economy of the steam turbine, which, Mr. Mavor states would be, under such conditions, better than that which has yet been obtained at sea. He estimates that the system proposed would deliver an electric horse-power to the driving motors for 12.2 pounds of steam per horse-power-hour. Moreover, this economy would be well maintained at all speeds of sailing, since the speed of the prime mover would not itself be varied.

The question of relative weights of the two systems is also important. Accurate data are not available on this point, but it is estimated that the decreased weight of the steam turbine as compared with the slow-speed marine engine will more than compensate for the weight of the heavy, slow-running motors and propellers. It would seem, therefore, that there are some inviting possibilities for the electric driving of ships, and it may be found, as has been the case in other applications of electric transmission, that what is in the first instance introduced as a convenience proves in practice to be an economy.

## ATMOSPHERIC ELECTRICITY.

A recent communication to *Nature* called attention to a very interesting phenomenon observed during a recent London fog. It seems that at Kew Observatory the potential gradient of the atmosphere has been recorded for many years past, and it has been noticed that this frequently obtains a high value of one or two hundred volts during fogs, but this condition usually lasts a short time only. One day during January, however, the instrument at Kew showed that the gradient exceeded 730 volts continuously from one in the morning until half-past nine. This potential gradient is defined as the difference in potential of the atmosphere per metre of height, and it seems remarkable that such values could exist without being noticed in other ways. In this case it is estimated that it must have been more than 1,000 volts to the metre. The question is raised, What has this difference in potential to do with the fog, and has it any bearing on the problem of dispersing fogs?

We have at various times called attention to the importance of studying the electrical phenomena of the air. Although there are many observatories which record the conditions from day to day, but little is being done in an experimental way. During the past year the Meteorological Department at Washington sent up a number of balloons with recording devices, and fortunately secured about nine-tenths of them after they had made their flight, and thus obtained a large amount of interesting information. But if we are to get any really valuable information which will lead to something, such experiments must be carried out on a much larger scale and over a much wider territory than has been done. It can hardly be doubted that the electrical condition of the air plays an important part in natural phenomena. It must have some effect upon all animal and vegetable life, even though this be slight, and it must also be a factor in affecting weather changes. Here is a field where those who are wasting much valuable time and money in uselessly playing with balloons might add greatly to our scientific knowledge, and perhaps benefit humanity.

## The Annual Meeting of the Underwriters' National Electric Association Electrical Committee.

The sixteenth annual meeting of the Electrical Committee of the Underwriters' National Electric Association was held in New York city at the rooms of the New York Board of Fire Underwriters on Wednesday and Thursday, March 25 and 26. Sessions were held both in the morning and afternoon, and every session was very well attended.

The committee reports on mercury-vapor lamps, rheostats, transformers, wiring of electric cranes, rules 24A-c, 25D, 25F and 49A-b, on recodification of National Electrical Code, and on variable-speed motors, were passed as printed in the bulletin issued by the Electrical Committee, with only minor changes in the wording.

The report of the Committee on Variable-Speed Motors was ordered printed in the supplement, and distributed.

The report of the Committee on Circuit-Breakers elicited a great deal of discussion. This report considered rules for the construction of circuit-breakers for 550 volts or less. Exception was taken to the suggestions issued by the Electrical Committee with regard to the mounting of the circuit-breakers, and this was amended to read: "Pieces carrying contact parts must be screwed to the base by at least two screws or else made with a square shoulder, dowel pin or equivalent device to prevent possible turning, and the nuts or screw-heads on the under side of the base on front-connected circuit-breakers must be countersunk not less than one-eighth of an inch and covered with a waterproof compound."

After some discussion it was decided that the sentence, "Hinges shall not be used to carry current," should be eliminated from the suggestion with regard to the connections of the circuit-breakers. It was the sense of the meeting that, in smaller sizes, it might be possible to devise a circuit-breaker in which the hinges could be used to carry current, and it was thought wise not to limit the field of the inventor and manufacturer by this clause.

Under the heading of tests of circuit-breakers the breaking capacity was discussed, and the paragraph was referred back to the committee for further elucidation. Circuit-breakers must successfully withstand 2,000 volts alternating current for one minute between live metal and ground, between poles in multipolar breakers, and between terminals with breaker open. The maximum rise in temperature of any part must not exceed thirty degrees centigrade when carrying rated current. In calibration the circuit-breaker must not have a plus or minus error greater than ten per cent at any point of its setting.

The suggestion with regard to the mechanism of multiple-pole circuit-breakers was changed so as to read: "Multiple-pole circuit-breakers must have poles and necessary trip-coils so arranged as to afford complete protection against overloads and short-circuits under all conditions met with in practice. All circuit-breakers must be provided with an easily accessible means for tripping them by hand, without danger to the operator."

Circuit-breakers must be plainly marked where the mark will be visible when installed, with the name of the maker and the current and voltage for which the device is designed.

The other suggestions made by the Committee on Circuit-Breakers were adopted, with the exception of 21 and 21e, which were referred back to the committee.

The report of the Committee on Street Railways was accepted, with minor changes in the wording.

The suggestion of the Committee on Switches and Cutouts with regard to bases, which affects rule 51C of the National Electrical Code, was accepted. The suggestions regarding the design, which affect rules 51 and 52, were also accepted, as were the suggestions regarding spacings.

The suggested changes in the rules of the National Electrical Code, governing cabinets, were referred to a committee of three, to report to the whole committee.

The reports from the laboratories of the National Board of Fire Underwriters were adopted in their entirety. The suggestion with regard to marking sockets and receptacles with current and voltage was the subject of considerable discussion, and the suggestion was made that, in addition to the voltage mark, particularly on lamps to be used with keyless sockets, the wattage rating should be placed. It was the sense of the meeting that when there was sufficient assurance from the manufacturers as to the permanency of type of the newer forms of incandescent lamps, the laboratories could evolve a plan for properly marking them.

The report of the Committee on Rule 13A, which was appointed to confer with committees from the National Electric Light Association, the Association of Edison Illuminating Companies, the American Institute of Electrical Engineers and the National Electrical Inspectors' Association, presented amended rules which had been suggested by these interests. These rules, as is well known, refer to the grounding of low-potential circuits, and apply only when, under normal conditions of service, there will be no passage of current over the ground wire. This report was referred back to the committee for further work. It was the sense of the meeting, however, that the rule with regard to the grounding of secondaries shall be mandatory when adopted by the committee.

The report of the Committee on Lighting on Low-Potential Systems (Other than Signs) on Exterior of Buildings was accepted with minor changes. The outline lighting must be connected only to low-potential systems. Open or conduit work may be used, but moldings will not be permitted. For open work the wires must have an approved rubber insulating covering. The supports must not be separated by more than two feet, and where the wires are run laterally across the building, in order that they may not be short-circuited or damaged by sleet and snow, they must be spaced at least two feet apart. Where flexible tubing is used it must be provided with sealed ends painted with a moisture repellent. The tubing must be kept a half inch from the surfaces wired over. For rigid conduit work the construction must be the same as for unlined conduit work. For the purposes of this rule flexible metal conduit or armoring will not be classed as moisture-proof. The outlining system must be protected by its own cutout and controlled by a switch independent of the building installation. The cutouts, time switches, flashers and similar appliances must be of approved design and enclosed in a waterproof cabinet. Sockets and receptacles used on outline wiring must be of the keyless porcelain type.

A communication was received concerning the emergency lighting of telephone switchboards. It was the sense of the meeting that rule 24Y should be so amended that it would apply to this work. Where two systems of wiring, one depending upon commercial service at standard voltages and the other on twenty-four volts from the storage batteries used in telephone service, were used in the same fixture, it was thought that this introduced an unnecessary hazard. Where two services were used in the same fixture also, there was danger of trouble from

crosses. A committee will be appointed to confer with the contractors on the matter of wiring of fixtures. A committee will also be appointed to look into the matter of more definite specifications with regard to the construction of switchboards.

Concerning the suggested changes in the rules, the amendment to Rule 2, Section a, was referred back to the subcommittee. The amendment to Rule 2, Section c, "must, where not in conduit, be kept so rigidly in place that they can not come in contact," was accepted.

The committee also recommended the adoption of the following amendments or changes, and their recommendations were approved by the meeting:

Rule 12, Section g—Amend the last sentence of fine-print note to read: "The conduit to be provided with approved service head and the inner end to extend," etc.

Rule 22, Section a—Add: "On all service wires the switch must be placed on overhead or underground construction at the most conveniently accessible place, and as near as possible to the service entrance."

Rule 24, Section o—Make first recommendation read "a turn of ninety degrees."

Rule 24, Section p—Amend second fine-print note to read: "The same conduit must never contain circuits of different systems, but may contain not exceeding four two-wire or three three-wire circuits of the same system."

Rule 24A, Section a—Omit word "underground" in first line in fine-print note.

Rule 24A—Add new section as follows: "All bends must be so made that the armor of the cable will not be injured; the radius of the curve of the inner edge of any bend not to be less than one and one-half inches."

The amendment to Rule 26, Section a, "must, when supported from or attached to gas piping, be insulated therefrom by means of approved insulating joints," etc., was referred to the Committee on Rule 13A.

Rule 26, Section c—Change to read: "must be free from contacts between conductors and fixture, short-circuits and ground connections, and must be tested for such conditions before being connected to the supply conductors."

Rule 26—Add new section to read as follows: "The so-called flat canopy sometimes used on electric and combination fixtures is not approved except where outlet boxes are used."

Rule 26—Add new section: "must, when installed outside of frame buildings, be of watertight construction."

The whole of the new section of the additional matter to be added to Rule 26, referring to the grounding of low-potential systems in iron-pipe conduit, was referred to the Committee on Rule 13A.

Rule 28, Section c—Insert after "show-windows" the words "show-cases or similar places."

Rule 31A—Amend Section b, paragraphs 1, 3 a, 4 c, also Section c, paragraph 1, and Section e, paragraph 1, so as to allow of the use of approved armored cable in place of approved conduit.

Rule 31A, Section b, 4e—Change to read "cables must be made up of approved stranded, rubber-covered wires and must be continuous," etc.

Rule 31A, Section c, paragraph 2—Amend to read as follows: "All pendant lights must be equipped with approved reinforced cord, armored cable or steel-armored flexible cord."

Rule 34, Section a—Amend to read as follows: "must not be permitted, under any pretence, in the same circuit with trolley wires with a ground return, except in electric railway cars, car-houses, power-houses, passenger and freight stations connected with the operation of electric railways." On this suggestion there was some discussion, and it was the sense of the meeting that such discretion should be used by the Codification Committee as would include all buildings such as are essentially not dangerous when wired from electric railway systems.

Rule 49, Section h—Amend by omitting the words in the third line "when removed from the pipe entire."

Rule 51, Section j—Amend fine-print note to read as follows: "Triple-pole switches designed with 125-volt spacings between adjacent blades should be marked 125 volts, and may be used on direct-current, three-wire systems having 125 volts between adjacent wires, and 250 volts between the two outside wires.

Rule 51, Section n—Amend by omitting from the rule the words "the contacts being arranged so that a thoroughly good bearing at every point is obtained."

Rule 51, Section n—Amend by omitting the fine-print note.

Rule 51, Section o—Amend by omitting the last sentence.

Rule 51, Section s—Amend second paragraph by adding the words "For switches rated higher than ten amperes this test shall be at twenty-five per cent overload.

Rule 51, Section s—Add the following fine-print note after the first paragraph: "Snap switches of the spring-break pattern, normally complying with the above requirements, but with movement of the contact carrier under control of the operator at any point in the operation of the device, must be considered in a class with switches of the regular knife-blade pattern and conform to the specifications of Rule 51k."

Rule 51, Section t—Amend second paragraph by omitting the words "on the back of the face plate or."

Rule 53, Section k—Amend so as to be interpreted that this indicates the exact conditions of the test, and not the maximum.

Rule 60, Section a—Add the following fine-print note: "Wood or other suitable material may be used for parts of the casings or covers of drum controllers, provided these parts are properly lined or treated with fire-resisting materials and so arranged that should the combustible parts within the casing be ignited, the fire would be confined within the casing or cover."

Taking up the miscellaneous suggestions, the committee recommended the adoption, and the general meeting voted to approve the committee's recommendations, as follows:

All self-fastening knobs, cleats or supports must be secured with suitable screws. All floor receptacles or fittings must be of approved watertight type. This was further referred to the laboratories, and is an indication to manufacturers and contractors that ordinary moistureproof wall sockets and receptacles will not be accepted for watertight floor installation.

In all concealed knob and tube construction wiring must, as far as possible, be confined to right-angle work.

Ground connections for conduit systems must be made with copper wire and clamps, wire to be not less than No. 6 Brown & Sharpe gauge. Referred to Committee on Rule 13A.

Wires in molding must be in continuous lengths from outlet to outlet or from fitting to fitting, no joints or taps to be made in molding. Where branch taps are necessary in molding, approved fittings for this purpose must be used.

The adoption of a rule forbidding the dead-ending of a circuit on a cleat-type socket or rosette.

The adoption of specifications for waterproof sockets and fixtures for use in damp places. Referred further to the laboratories.

Rule 3, new clause requiring switchboards to have main switch, main cutout,

ammeters, voltmeters and ground detector. Referred to a switchboard specification committee to be appointed.

Rule 13A, making grounding of transformer secondary compulsory when primary exceeds 550 volts. Referred to Committee on Rule 13A.

Rule 45, add a new section covering specifications for approved stage cable such as are required by theatre rules. Referred to a wiring and fixture committee to be appointed.

Suggest that permission be given to ground electrical fixtures in installations where the fixtures are not connected to gas pipe and are wired to low-potential distributing systems run in iron pipe conduit.

Suggest that permission be given to use bare or insulated neutral wires when such wires are run in iron pipe conduit on secondary distributing systems to grounded fixtures. Referred to Committee on Rule 13A.

Include in Class D specifications for "approved multiple-conductor, metal-sheathed cable," referred to under Rule 8b. Referred to laboratories.

Include in Class D specifications for "automatic motor-controlling devices such as are used for elevators, printing presses," etc. Referred to Committee on Rheostats.

Include in Class D specifications for flexible cable such as is used in theatre and elevator work. Referred to a committee to be appointed.

Allow the carrying capacity of weather-proof wire, as given in No. 16, to be used for rubber-covered wire in connection with induction motors.

In all places in the code where "slate or marble" is called for, add the alternative of "soapstone."

The matter of sign specifications was discussed, and this will be referred to a new committee which will be appointed.

The question of the installation of tungsten lamps in series was discussed, and it was the sense of the meeting that there was no occasion for action.

Rule 28c was discussed, and the matter of fixtures and pendants being prohibited when supporting a load in excess of two pounds was referred to the laboratories so as to indicate what types of lamps with reflectors or clusters might be used with pendants.

The question of bonding conduit and armored cable with gas pipe, under reasonable conditions, was referred to the Codification Committee.

Several resolutions were read, one suggesting to the underwriters' inspection bureaus the co-operation with the underwriters' laboratories in the label service, and another to the underwriters' inspection bureaus suggesting the use of the National Electrical Code as promulgated by the Electrical Committee, without amendment or addition.

A resolution of thanks was tendered to the New York Board of Fire Underwriters for the use of the rooms for meeting purposes.

Announcement will be made later of the several committees upon appointment.

The personnel of the Electrical Committee is as follows: F. E. Cabot, chairman; W. A. Anderson, G. E. Bruen, H. C. Eddy, E. A. Fitzgerald, J. C. Forsyth, C. H. Hill, H. O. Lacount, William McDevitt, Dana Pierce, A. M. Schoen, C. M. Goddard, 53 Kilby street, Boston, Mass., secretary.

## Chicago Light Ordinance Passed.

The Commonwealth Edison rate ordinance was passed by the Chicago (Ill.) city council on March 24. The amendments accepted by the council and incorporated into the ordinance impose upon the company an obligation to maintain its voltage with a fluctuation not greater than five per cent. The company is protected in case of accident causing a larger fluctuation, and is given thirty days in which to make repairs. A clause makes it incumbent upon the company to extend its lines in case reasonable returns in patronage are assured by such extension. The city electrician is made the arbiter as to whether a consumer should have meter service or not.

The opponents of the bill sought to have various amendments made, and the most important of those rejected were, limiting the emergency rates to be charged by the company to fifty per cent over and above the regular maximum rates, and an amendment compelling the company to furnish free installation within a certain distance of the feeding wires and conduits.

The new rates prescribed by the ordinance are to be in force up to August 1, 1912. The city is to receive three per cent compensation on the gross receipts of the consolidated corporation, which will amount, it is estimated, to something over $300,000 a year. The new charges are scheduled as follows: Up to July 31, 1908, fifteen cents per kilowatt-hour; secondary rate, same period, nine cents per kilowatt-hour. Maximum rate after July 31, 1908, thirteen cents; secondary rate, 1909, eight cents. Secondary rate for the last three years, seven cents.

## Binding-Posts for Snap-Switches.

The Underwriters' Laboratories, Incorporated, under the direction of the National Board of Fire Underwriters, has issued a circular to electrical jobbers and contractors in reference to the agreement entered into between manufacturers of snap-switches and the laboratories covering the gradual replacement of the set-screw form of binding-post on these devices. On July 1, 1908, all cards registering approval of switches of the set-screw type will be withdrawn and new cards will be issued registering approval of the products of those manufacturers who shall have submitted strictly commercial samples of their entire line having the new form of contact. The necessary time will be allowed to dispose of reasonable stocks of switches in hands of jobbers and others, provided manufacturers file with the laboratories assurance that after July 1, 1908, no switches with the set-screw form of binding-post will be made up in their factories. The October, 1908, edition of the List of Approved Fittings will show only those devices on which approved cards are then outstanding. It is the intention of this action to effect a gradual replacement of the older form of binding-post without causing depreciation in value of stocks on hand July 1, 1908.

## United States Civil Service Examination for Engineer, Indian Service.

The United States Civil Service Commission announces an examination on April 15 to secure eligibles from which to make certification to fill a vacancy in the position of engineer (with knowledge of ice machinery, pumping and electrical plants), $900 per annum, Indian Service, Colorado River Agency, Ariz., and vacancies as they may occur in the Indian Service. Examinations will be given in the following branches: Steam engineering, electrical engineering, heating, refrigeration, gas and gasolene engines, hydraulics. The examination is open to all citizens of the United States who comply with the requirements. Applicants should at once apply either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the Board of Examiners in the various cities where the commission has offices. In applying for this examination the exact title, "Engineer, Indian Service," should be used in the application, and the particular branch or branches in which examination is desired should be indicated at the head of the application.

## FINANCIAL REPORTS OF ELECTRIC COMPANIES.

MEXICAN TELEGRAPH COMPANY.

The report of the Mexican Telegraph Company for the quarter ended March 31, 1908, partly estimated, shows gross receipts of $186,000; expenses, $36,000; net, $150,000; other income, $25,500; total income, $175,500; transferred to Mexican Government, $7,500; balance, $168,000; dividends payable in April, $71,753; surplus, $96,247, making the total surplus $2,478,142.

TWIN CITY RAPID TRANSIT COMPANY

The Twin City Rapid Transit Company for February shows gross earnings of $453,944, which compare with $149,802 in 1907. The expenses were $253,643, compared with $217,468. February net income was $200,301, compared with $202,334. Charges, taxes and preferred dividend amounted to $122,789, compared with $115,258, making February surplus $77,512, compared with $87,076. The gross earnings for January and February of the current fiscal year were $923,835, compared with $876,639. The expenses were $511,844, compared with $460,565. The net income for the two months was $411,991, compared with $416,074. Charges, taxes and dividends for the two months were $244,744, compared with $230,517, leaving a two months' surplus of $167,247, compared with $185,557.

UNION ELECTRIC LIGHT AND POWER COMPANY.

The Union Electric Light and Power Company, St. Louis, Mo., shows gains in gross and net profits and surplus for the year ended December 31 last. Gross earnings were $2,855,417, or $612,936 more than those for the previous year. Expenses and taxes were $1,116,562, or $72,241 less, and net earnings were $1,738,855, a gain of $685,177. Interest and miscellaneous disbursements involved $981,005, or $466,707 more than those for the previous year, leaving a surplus of $757,850, or $218,470 more than for 1906.

NIAGARA FALLS POWER COMPANY.

The annual report of the Niagara Falls Power Company and the Canadian Niagara Power Company for the year ended December 31, 1907, shows gross earnings of $1,683,223, an increase of $312,515; net earnings, $1,236,147, an increase of $191,963; total income, $1,398,682, an increase of $275,098. After deducting fixed charges there was a surplus of $210,673, a decrease of $126,014. The reserve for improvements, betterments and depreciation was $654,429.

CENTRAL UNION TELEPHONE COMPANY.

The annual report of the Central Union Telephone Company for the year ended December 31, 1907, shows total revenue of $4,611,485. This is divided as follows: From exchanges, $3,335,899; tolls, $1,086,687; other sources, $188,899. The total expenses were $3,370,676, divided as follows: General, $543,822; operating, $1,216,101; maintenance, $1,295,510; miscellaneous, $315,243; net income, $1,240,809; interest and other charges, $1,114,449, leaving a surplus for the year of $126,360, making the profit and loss surplus $452,381. The surplus for the year was equal to 2.31 per cent on the $5,450,927 capital stock. The total exchange stations at the end of the year were 185,935; toll and pay-stations, 2,922; private line stations, 4,884; total stations, 193,741; number of exchanges, 310.

Consolidations of competing plants were made at thirty-nine places, with 6,582 stations, in Ohio, Indiana and Illinois. Sub-licensee arrangements have been made with non-competing companies for toll business in 192,000 stations, making nearly 400,000 telephones connected with the system.

HONOLULU RAPID TRANSIT AND LAND COMPANY.

The annual report of the Honolulu Rapid Transit and Land Company for the year ended December 31, 1907, shows gross earnings of $367,134; expenses and taxes, $201,228; other income, $7,475; total income, $173,381; charges, depreciation, etc., $100,968; surplus, $72,413; dividends, $45,000; net surplus, $27,413.

## No Consolidation of Wireless Companies.

In view of announcements that have recently been made that plans were under way for the consolidation of the Marconi Wireless Telegraph Company, Limited, of England, the Marconi Wireless Telegraph Company of America, and the United Wireless Telegraph Company, John Bottomley, vice-president and secretary of the Marconi Wireless Company of America, has issued a statement denying the assertion that the United Wireless Telegraph Company had acquired control of the Marconi system. Mr. Bottomley states that the managers, directors and a majority of the stockholders of both the Marconi companies are not interested in any wise in the United Wireless Telegraph Company, and that the latter has no agreement or prospect of agreement by which it will obtain control of either of the Marconi companies.

Vice-President S. S. Bogart and Secretary Marshall, of the United Wireless Telegraph Company, have disclaimed any knowledge of further consolidation of wireless companies. They think that the following paragraph in the United company's latest prospectus should be construed broadly as a plan of future development:

"The purpose in the organization of the United Wireless Telegraph Company is to consolidate the wireless companies and to further unify the wireless situation by taking over all wireless companies or wireless inventions that might or could in any way come in competition. By this means the development of wireless telegraphy could be carried on in a constant and uniform manner without the enormous expenses incident to continuous litigation and the losses occasioned by competition and interference of rival companies."

## Municipal Ownership Deal in Winnipeg.

Arrangements have been made for the purchase by the city of the entire holdings of the Winnipeg (Manitoba) Electric Company, estimated to be worth in the neighborhood of $15,000,000. For some weeks negotiations have been in progress, but it was not until March 30 that the company decided to dispose of the property, Winnipeg buying all shares at closing prices in Toronto on that day.

The determination of the company was hastened by arrangements now being made by the city for the construction of a municipal power plant at Lacdubonnet at a cost of $3,500,000 to enter into competition with the company, which now has a monopoly in the city for supplying electricity.

The company also has a franchise for supplying gas and does a large business without competition. The street railway system also has a franchise preventing any one else from running cars. All this passes into the hands of the city, which already owns its own waterworks, stone quarries and asphalt plant, while the provincial government owns the telephone system.

## Automatic Telephone Merger.

The Automatic Electric Company and the Strowger Telephone Company merger has been ratified by stockholders of both companies. It is announced that independent interests which will lease the Illinois tunnel automatic telephone service will pay a higher rental than the $5 per telephone per year, which was previously offered.

## THE VALUE OF MEMBERSHIP IN THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

BY CALVERT TOWNLEY.

It is being recognized more and more as time goes on by investors that the employment of a competent engineer to study the requirements of an undertaking and to prepare designs and specifications is necessary for all projects of considerable magnitude. So far has this feeling grown that the present time may not inaptly be called the age of engineering. As a natural consequence the engineer's sphere of usefulness has been so widely extended and the variety of subjects upon which he must pass has become so large that great specialization has become imperative. The corollary of this condition is that no engineer who has achieved more than mediocre success in his own line can hope to be thoroughly competent in general engineering lines, and as a consequence the co-operation of engineers operating in all different lines has become a matter of course.

The different branches of electrical engineers are no exception to the necessity for specialization laid down above, and the rapid advancement which has been made in the development of electricity for various uses imposes the duty of great continued effort on the part of electrical engineers to keep up to the times even in their own particular lines of work. It is here that the American Institute of Electrical Engineers becomes of particular value to the individual member. It not only places before him, through the medium of its proceedings and transactions set forth first hand by those who are best qualified to speak, a large amount of valuable information about many of the most important electrical questions, but it gives him an opportunity to get and keep in personal touch with other engineers in his own field of work, both in his own locality and throughout the country. This fact constitutes perhaps the reason which appeals most strongly to the average man why he should be a member of the Institute, but it is by no means the only reason. The united action of a body of men being always more effective than the collective individual action of the men composing that body, by allying himself with the Institute every engineer helps by his moral support, as well as by his counsel and advice, the advancement of his profession as a whole and the general standing of American electrical engineers in this country and throughout the world, a condition which redounds more or less indirectly, but nevertheless with great effect, to his own personal benefit.

American engineers, as compared with their brothers in other countries, unquestionably have been forging ahead of late years, and I think it is generally conceded that the construction of the Engineering Societies Building, in New York, and the concentration there of three national societies, as well as a large number of other important engineering bodies, has done more to bring together the several forces working toward the advancement of American engineers than could perhaps be done in any other way. To all who have been in touch with this situation the co-operation of these different bodies has been most gratifying. Perhaps the most conclusive proof of the benefits derived by individual engineers from their connection with the American Institute of Electrical Engineers is the fact that every man who joins stays in.

## Government Ownership of Telephones Unpopular in Manitoba?

The following news despatch is reprinted from a recent issue of the New York *Tribune*, and is interesting at this time in view of the announcement that the Canadian Government is considering further purchases of telephone utilities:

"Winnipeg, Manitoba, March 20.—So far as this province is concerned government ownership of telephones is not meeting with the success which was promised while the present government was canvassing the province for re-election. The speakers told the people that under government ownership existing telephone charges would be cut in two and that after several years of operation the rates would be still further reduced.

"All these assertions and promises are forgotten now that the provincial government has purchased the Bell system in Manitoba, and instead of a reduction in the rates an advance has been ordered in certain classes. The province paid $3,300,000 for the Bell lines and equipment, and when the purchase price was announced Francis Dagger, a telephone expert, who is known all over the American continent, declared that at the price paid by the government the system could not be run on a paying basis unless the rates were advanced.

"The local government then apparently began to realize the fact that at least a million dollars too much had been paid to the Bell people, and some competent experts alleged an excess payment of a much greater sum. To make a favorable showing an order was issued by the commission appointed to look after the workings of the system that under no circumstances would free telephones be allowed, and the ninety instruments for which no revenue was being received under the Bell régime were taken out unless the users cared to pay the regular rates to have them remain. This increased the earnings of the system by some $2,500 a year. But this was not enough, so an order has now been issued informing all doctors and nurses that in future their yearly rate will be $50, instead of $40 under the Bell rule, and thus another $3,000 or $4,000 is added to the yearly receipts of the Department of Telephones.

"These two items, however, amount to little, and now the commission is considering other ways to increase the revenue, while the general service given to subscribers is no better than before. In fact, many persons assert that the Manitoba Government is not giving as good service as the Bell company did under the same conditions. The promise of reduced rates seems as far from fulfilment as ever, and whenever a member of the provincial Department of Telephones or a member of the commission is asked when the promised reduction of rates is likely to become effective he replies with the now stereotyped phrase, 'I have nothing for publication on the matter.'"

## Gossip from London.

We have received another interesting letter from James P. McQuaide, who is now acting as special agent for the Equitable Life Assurance Society of the United States at 6 Southfield Gardens, Strawberry Hill, Twickenham, England.

Mr. McQuaide writes that James Cummings has just returned from Brussels, where he has closed a contract for 1,300,000 feet of conduit. Frank Gallagher, son of the vice-president of the National Conduit and Cable Company, spent a week in London, and then went to Ireland to spend St. Patrick's Day and a few pounds. H. F. Parshall, who formerly represented the General Electric Company, of Schenectady, N. Y., at London, reports business not very active.

Mr. McQuaide comments on the London underground distribution, which is laid on the solid system. He concludes that possibly, in a few years, they may find out about the drawing-in system.

# Murnau-Oberammergau Single-Phase Railway.

By Cyril J. Hopkins.

THIS single-track road is equipped for a trolley pressure of 5,500 volts at sixteen cycles, water power, supplied at a head of 23.75 metres (seventy-eight feet) by a canal 1,400 metres (seven-eighths mile) long, being employed for the generation of current.

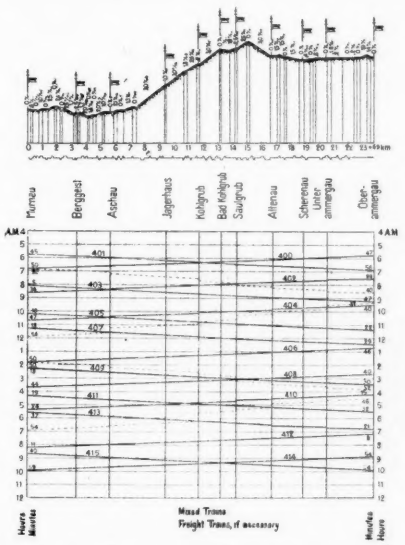



FIG. 1.—GRADE AND TRAIN DIAGRAMS.

The service comprises principally passenger traffic, with considerable lumber freight in the colder months, when the former is less, the regular trains per day being in winter twelve and in summer sixteen. A train diagram for the summer schedule is given in Fig. 1.

The four motor-cars weigh twenty-nine tons (2,000 pounds) each, two being constructed to carry second and third-class passengers only (Figs. 2, 3 and 12), while the other two are composite cars with postal and baggage compartments, being especially designed for the winter service when the demand for passenger accommodation is small. Trains usually consist of one motor-car with one or two passenger trailers, the latter each weighing eleven tons empty. Frequently, however, the trains are of mixed composition, containing one or two freight trailers in the place of a passenger trailer. Figs. 2, 3 and 4 illustrate the types of trains used. These are limited to a maximum weight of sixty tons.

The track contains numerous sharp curves, which appear to have been adopted to minimize the cost of construction in overcoming the grades, the maximum grade, Fig. 1, being three per cent for a stretch of three and one-half miles. The maximum speed down grade is limited to about twenty-four miles per hour, giving a schedule speed of twelve miles per hour, when making eight intermediate stops over the complete journey of 23.6 kilometres (14.7 miles).

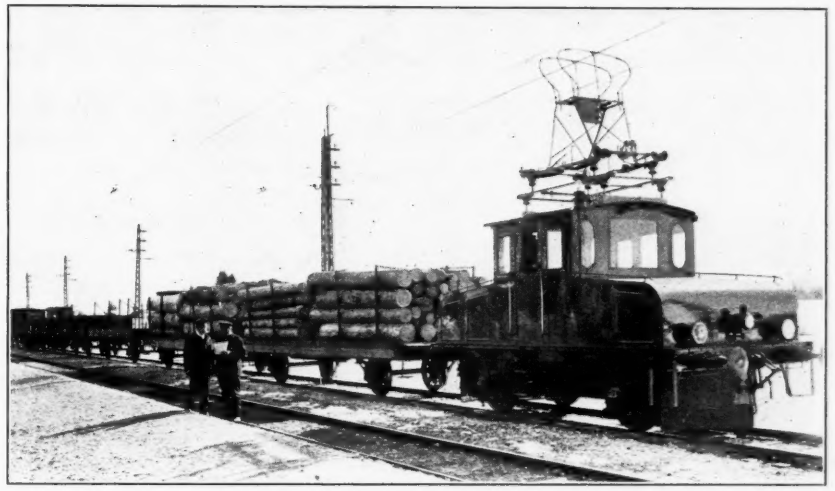


FIG. 4.—A TYPICAL FREIGHT TRAIN.

FIG. 2.—PASSENGER MOTOR CAR AND TRAILER.

FIG. 3.—MIXED TYPE OF TRAIN AT STATION.

The railway connects two towns of not more than 3,000 inhabitants each, Murnau, some forty miles southeast of Munich, to the famous Oberammergau, renowned for its decennial Passion play. It has nine intermediate stations, the

average distance between which is therefore one and one-half miles.

Fig. 5 shows the general arrangement of the system with respect to the location of the power station and copper layout for lighting and power.

Before entering into the matter of costs it might be interesting to relate a few of the conditions under which the road has reached its present state. The line was built in the year 1899-1900, with the intention of installing a three-phase system, with 5,000-volt trolleys and 750 volts across the motors, supplied through twenty-four transformer stations placed along the track. As a further source of revenue, electric energy was to be sold to private customers. On the grounds, less of a technical nature than a financial one, only the lighting installation was completed, the road being operated by steam. In 1904 the Munich Local Railway Company purchased the road, including the power station, which contained up-to-date water turbines by Voith, of Heidenhelm, and plans for electric operation were again taken up.

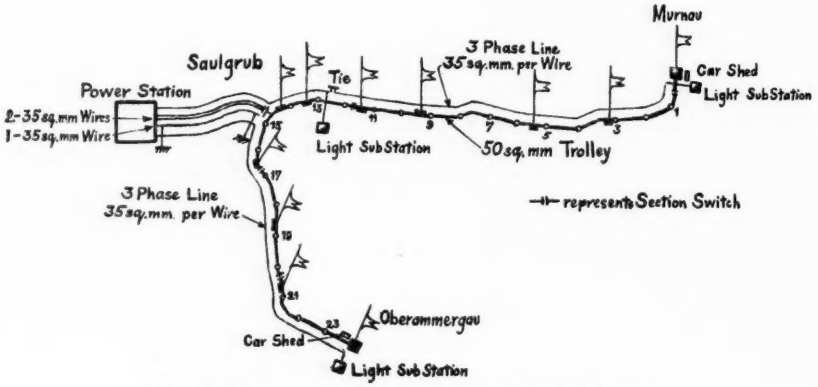



FIG. 5.—DIAGRAM OF SYSTEM SHOWING COPPER LAYOUT.

Owing to the uneven nature of the route, a three-phase system was deemed unsuitable, as with the motors in parallel the almost constant speed demanded too low a speed on the level, or too much power on the grades, taking into consideration the available water power. The death-blow for the three-phase system resulted from the study of the overhead line with its copious switching devices.

The following comparisons in cost and efficiency serve to illustrate the commercial value of the various systems, as determined in the interests of the Munich Local Railway Company for this particular proposition:

| System. | First Cost. Per Cent. | Efficiency. Per Cent. |
|---|---|---|
| Single-phase | 100 | 71 |
| Three-phase | 116 | 66 |
| Direct current | 125 | 62 |

Tests relating to the watt-hour consumption have been made with sixty-ton trains, driven according to time-table. The results obtained are recorded in Fig. 6. Simultaneous readings at the car and power station were taken in order to check the results. These tests gave an average energy consumption of sixty-three watt-hours per ton-mile. By comparing this amount with the energy expended at the car-wheels in overcoming grades, friction and acceleration for a complete double journey, including sixteen stops in the 29.4 miles, with a maximum speed, excepting down grades, of eighteen miles per hour, and allowing nine pounds per ton for friction while the current is on (a distance of 33,000 metres, or 108,000 feet), the efficiency of the system may be determined as follows:

| | Foot-Pounds. |
|---|---|
| Work done in overcoming grades, demanding a total lift of 327 metres or 1,070 feet = 1,070 × 2,000 | = 2,140,000 |
| Work done in overcoming friction = 108,000 × 9 | = 972,000 |
| Kinetic energy stored during acceleration periods = (18 × 1.47) × ½ × 16 × 2,000/32 | = 350,000 |
| Total foot-pounds per ton-trip | = 3,462,000 |

Whence the average watt-hours per ton-mile

$$= \frac{3{,}462{,}000 \times 746}{33{,}000 \times 60 \times 29.4} = 44.5$$

Showing an efficiency of $100 \times 44.5/63 = 70.7\%$.

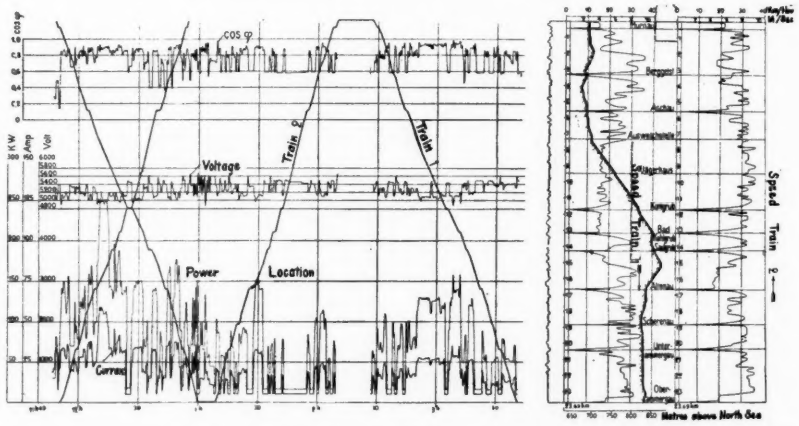



FIG. 6.—RECORDS OF TRAIN RUNS, SHOWING POWER CONSUMPTION, CURRENT, VOLTAGE, POWER-FACTOR, SPEED, GRADE AND LOCATION OF TRAIN.

Having outlined the general conditions of the system, the first and annual costs thereby involved may be better understood. The figures contained in the subsequent portion of this article have, for the most part, been gathered from direct information, but in order to complete the first costs of the whole system from an outsider's point of view, it has been necessary to estimate certain quantities, basing these estimates on a personal inspection and descriptive publications by the contractors. As will be observed, the first costs given below are determined from an electrical standpoint and do not include maintenance of way and administration charges.

ITEM I—POWER STATION.

The design of the power station is illustrated in Figs. 7, 8 and 9. The principal machinery may be seen to comprise two water turbine sets, each consisting of a 500-horse-power, 240-revolution-per-minute Voith spiral turbine; a flywheel of about four and one-half tons and ten inches diameter; a Voith flexible leather coupling; a 280-kilowatt (P. F. = 0.8), 5,500-volt, sixteen-cycle, one-phase generator; a 150-kilowatt (P. F. = 0.9), 5,000-volt, forty-cycle, three-phase generator.

There are also installed two separately driven, twenty-kilowatt, 150-volt exciters, each connected by a flexible coupling to a thirty-horse-power, 500-revolution-per-minute Voith turbine and furnished with a flywheel. Energy for lighting the station and operators' dwelling-houses is obtained from these machines, not more than fifteen kilowatts being required to excite a set of generators.

The total cost of this machinery is estimated at $40,000.

The switchboard, as shown in Figs. 8 and 9, has six marble panels, which are separated by a thirty-three-inch passage

from the high-tension gear, supported on an iron framework according to common practice. It is itemized below:

Two one-phase panels equipped with ammeter, voltmeter, wattmeter, plug switch for synchronizer, double-pole oil switch with automatic time release, and field regulator each.

Two three-phase panels equipped with ammeter, voltmeter, wattmeter, three-pole oil switch (non-automatic), and field regulator each.

One three-phase panel equipped with two ammeters, two three-pole automatic oil switches for outgoing lines.

One exciter panel for two exciters, equipped with two ammeters, one voltmeter with plug connections, three double-pole switches, and two field regulators.

Two sets of synchronizing gear.

Two watt-hour recording instruments on back of board.

Main fuses and high-tension blade switches, lightning arresters and water resistances in special chamber.

Total cost of switchboard is estimated at $4,000.

The maximum dimensions of the power station floor are approximately sixty feet by seventy-five feet, and the height of the building above the floor is about twenty-five feet. Estimated cost of power-station building, with ten-ton crane (forty-six foot span), $20,000.

These estimates for the power station have necessarily to be divided between the private lighting and the railway systems. Since the former embraces an installation of the order of 3,000 sixteen-candle-power lamps, while the demands on the three-phase power for railway purposes accrue from the employment of sixty-four sixteen-candle-power lamps, a thirty-two and a six-horse-power motor and batteries for train lighting, about one-sixth (or fifty kilowatts) of the installed three-phase capacity should be credited to the railway system; whence the proportion of costs of the power station to be charged against the railway is $(560 + 50)/(560 + 300)$, or about seventy per cent of the total, giving for

| | | |
|---|---|---|
| Machinery | $44,000 \times 70\% =$ | $30,800 |
| Building | $20,000 \times 70\% =$ | 14,000 |

Adding ten per cent for engineering and contingencies, the gross costs are—for

Machinery $34,000
Building 15,000

ITEM II—TRANSMISSION AND TROLLEY SYSTEM.

The transmission line comprises three thirty-five-square-millimetres (70,000 circular mils) wires and has a length of 1.9 miles, whence the cost of this copper at twenty-two cents per pound, plus three-quarter cent per foot for installing, is $1,500.

The trolley line, shown in Fig. 5, has a cross section of fifty square millimetres (100,000 circular mils or 1/0 Brown & Sharpe), whence its cost, allowing fifteen per cent additional copper for extra trackage at stations on the 14.7 miles of road and one and one-half cents per foot for erection, is $7,500.

The poles for supporting the conducting lines are wood, substituted at curves and stations by wrought-iron lattice poles, which thus comprise about fifteen per cent of the total number in each line, with an additional fifteen per cent for poles at sidings. They are spaced on an average 110 feet apart (forty-eight per mile). The cost of these individual poles is estimated below:

Transmission Line—Thirty-three-foot wooden pole erected and fitted with three insulators and brackets, $12; twenty-eight-foot iron lattice pole erected and grounded, with concrete foundation (one cubic yard) and fittings, $70.

Trolley Line—Thirty-three-foot wooden pole erected with angle iron bracket arm, two Brooklyns, two porcelain insulators, ear and span wire, $24; twenty-eight-foot iron lattice pole erected and grounded,

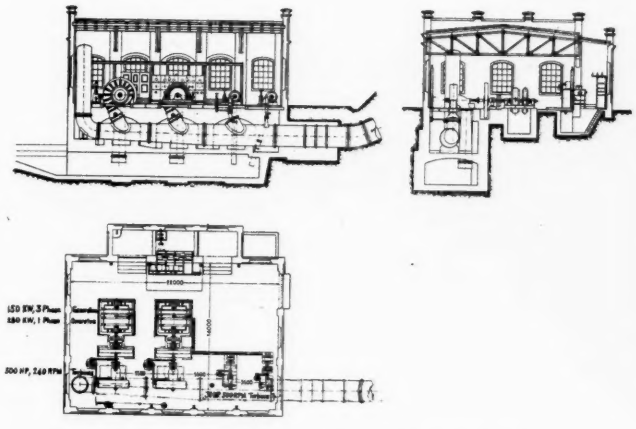


FIG. 7.—PLAN AND SECTIONAL VIEWS OF POWER STATION.

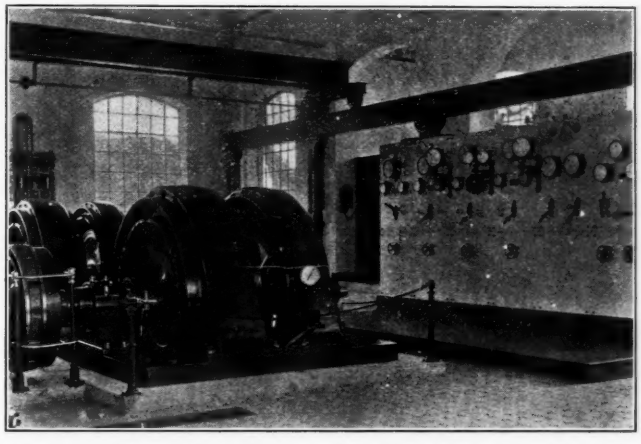


FIG. 8.—INTERNAL VIEW OF POWER STATION, SHOWING SWITCHBOARD AND ARRANGEMENT OF GENERATORS.

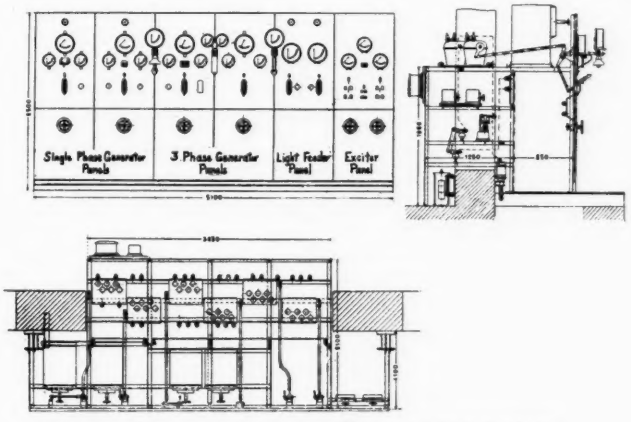



FIG. 9.—PLAN AND ELEVATION VIEWS OF SWITCHBOARD.

with concrete foundation, bracket arm and fittings, $85.

Number of wooden poles in transmission line, $1.9 \times 48 \times 85\% = 78$, representing approximately $1,000.

Number of iron poles in transmission line, $1.9 \times 48 \times 15\% = 14$, representing approximately $1,000.

Number of wooden poles in trolley line, $14.7 \times 48 \times 85\% = 600$, representing approximately $15,000.

Number of iron poles in trolley line, $14.7 \times 48 \times 15\% = 106$, representing approximately $9,000.

Cost of additional iron poles at station sidings, $9,000.

Add for incidentals, including twelve horn lightning arresters, four section insulator outfits, about 100 safety short-circuiting loops (installed at stations and crossings, see Fig. 10), $1,000.

Whence total cost of transmission and trolley system = $45,000.

Adding ten per cent for engineering and contingencies = $50,000.

The general method of suspension of the trolley wire, both from wooden and iron poles, is illustrated in Fig. 10. As would be expected for a 5,500-volt trolley line, the live wire is insulated at the hanger and also by Brooklyns and porcelain insulators—the latter being tested previous to instalment to withstand a mechanical stress of 1,000 kilogrammes, and an electrical stress under a spray of water at 32,000 volts.

ITEM III—CANAL.

The canal has been built along a hillside, the excavated matter being used on the spot for the fortification of the lower bank. Most of the labor would refer to the excavation of hard matter, 200 yards of this canal being in a tunnel through solid rock.

Approximate length of canal, 1,500 yards; approximate cross section, five square yards; cost of open canal at $2 per cubic yard is $13,000; cost of tunnel at $6 per cubic yard is $6,000.

Fig. 11 shows an open-steel aqueduct about ninety yards long and five square yards in sectional area, which forms a part of this canal. Its cost is estimated at $7,000.

It may be interesting to note that in January, 1906, during cold weather, the water washed away its embankment at one end of the steel aqueduct, the effect being visible in Fig. 11. This accident caused a holdup of from two to three weeks.

Other items to be considered are the dam some six feet in depth and thirty feet in width, head gates and sluice at the canal terminus; these are estimated at $9,000; total cost of canal, $35,000; adding ten per cent for engineering and contingencies, $38,000.

ITEM IV—BONDING.

The bonds for track and cross bonding are ten millimetres diameter (155,000 circular mils) copper rod with pin ter-

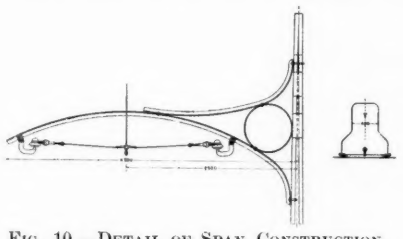


FIG. 10.—DETAIL OF SPAN CONSTRUCTION, SHOWING SHORT-CIRCUITING LOOP.

minals; the installed bonds are exposed. The track bonds are fastened at points some six or eight inches beyond the ends of the fish plates, have a length of over three feet and a weight of about one and one-half pounds, while the cross bonds are about six feet long and weigh nearly three pounds each.

Cost of track bonding per mile, both rails, thirty-six feet rails, at $1.50 per bond, $440.

Total cost of bonding 14.7 miles of track (fifteen per cent for sidings) is $7,500.

Cross bonds are installed at intervals of 330 feet, whence cost per mile at $2 each is $32.

Total cost of cross bonding, $600.

In order to insure against the existence of any dangerous difference of potential between the track rails and ground these rails have been grounded at sixty places along the line by means of a copper mesh-work lying in surface water, not less than one metre deep.

Estimated cost of grounding, at $5 per ground, $300; whence total cost of bonding and grounding is $8,400; adding ten per cent for engineering and contingencies, $9,000.

Based on measurements made by short-circuiting the system, resistances have been determined as follows: Apparent resistance of the 1.9 miles of transmission line, 1.33 ohms; ohmic resistance, 1.20; apparent resistance of one mile of trolley and rails, 0.66 ohm; ohmic resistance, 0.55 ohm.

The voltage drop when a sixty-ton train is running at the most distant point of the system from the power station (Murnau), with thirty amperes, amounts to 220 volts, or four per cent of 5,500 volts. In the most unfavorable circumstances, with two trains moving at the same time, the drop is only eight per cent.

It may be interesting to examine the preceding resistance data which has been published by the contractors. The resistance of 1.9 miles of transmission line at thirty degrees Fahrenheit is, neglecting the effect of ground at each end of the negative conductor, 1.7 ohms. If the effect of ground reduces this figure to 1.2 ohms, it means that the resistance of the ground itself must be of the order of four and one-half ohms. It will also be noticed, with regard to the trolley and rails, that the ratio of apparent to ohmic resistance is 1.2, taking into account the frequency sixteen and comparing it with the similar ratio set forth by the General Electric Company with reference to the Ballston (N. Y.) Line, *viz.*, 2.3, with a frequency of twenty-five, eighty-five-pound

FIG. 11.—AQUEDUCT FORMING PART OF CANAL.

track rails and a 3/0 trolley suspended from a steel catenary, but without a special grounding system, the result seems worthy of further investigation.

ITEM V—LIGHTING AND PUMPING SYSTEM.

The lighting system comprises two three-phase lines running from the power station to the railroad, whence one line

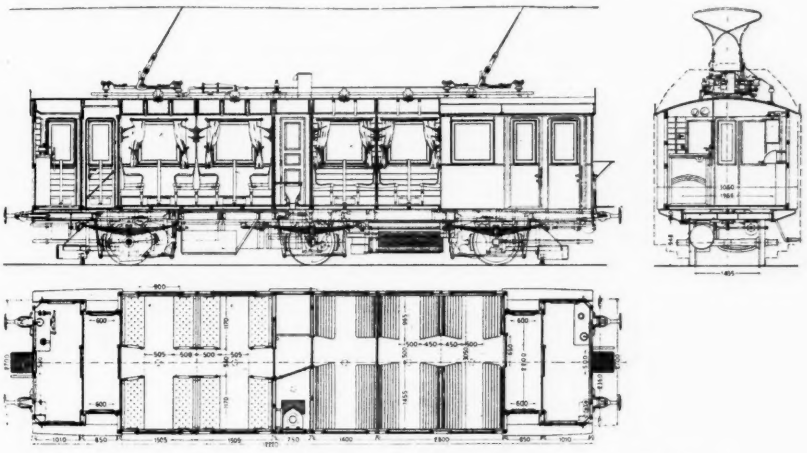


FIG. 12.—PLAN AND SECTIONAL VIEWS OF PASSENGER MOTOR CAR.

branches off in each direction to a terminus, making a total length of 18.5 miles of three-phase line, each conductor having a cross section of thirty-five square millimetres (70,000 circular mils).

Cost of copper chargeable to railway system (one-sixth of total), at twenty-two cents per pound and three-quarters cent per foot for erection, $2,600; cost of fittings (three insulators and supports per pole, see Fig. 4, at $4), chargeable to railway system (one-sixth of total), $600; cost of sixty-four lamps of sixteen can-

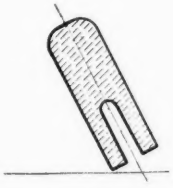


FIG. 13.—APPROXIMATE SHAPE AND SIZE OF BOW CONTACT PIECE.

dle-power, thirty-two horse-power pump installation, six-horse-power motor and equipment with necessary transformers, estimated at $3,300; whence total cost of lighting and pumping system is $6,500; adding ten per cent for engineering and contingencies, $7,000.

ITEM VI—CAR SHEDS AND EQUIPMENT.

The sheds are sufficient in capacity to house eight motor cars and two locomotives, or twice the present electric rolling stock. The Murnau shed is fitted with the necessary appliances to handle general repairs. The renewal of motor bearings is required every ten or twelve weeks, the air-gap in this time having been decreased about one-fortieth inch, or from 1.6 to one millimetre.

For the propulsion of cars in the sheds the current is supplied from an overhead line at 150 volts through transformers placed at the side of the track. The current is collected through a light vertical pole placed in a socket at the end of the car and having a flexible contact at its upper end. In consideration of the short length of track so traversed, resistance for speed regulation has not been provided, the motors being operated simply by a switch.

The cost of these sheds and equipment, including engineering and contingencies, is estimated at $7,000.

ITEM VII—LAND.

For power-house, at, say, five cents per square foot, on four times the maximum dimensions, 60 feet × 75 feet × 4 = 18,000 square feet, or $900; for car sheds, at, say, ten cents per square foot, on three times the area of the cars capable of being stored = 40 feet × 10 feet × 3 = 12,000 square feet, $1,200; for canal, at, say, three cents per square foot, on twice the surface area of the water, 4,500 feet × 15 feet × 2 = 130,000 square feet, or $4,100; total cost of land, $6,200; allowing for engineering and contingencies, $7,000.

ITEM VIII—TELEGRAPH SYSTEM.

Means of communication between all stations is accomplished by telegraph. The nature of the service has not been found to demand a signal installation, permission to proceed from each station being given by the station master.

Estimated cost of simple aerial line erected, with fittings, instruments, engineering and contingencies, $1,000.

ITEM IX—ROLLING STOCK.

Photographs of the rolling stock are given in Figs. 2, 3 and 4. Sectional and elevation views of a motor car are shown in Fig. 12, from which it will be seen that the seating capacity is forty-six: thirty third-class and sixteen second-class. Each motor car has three axles

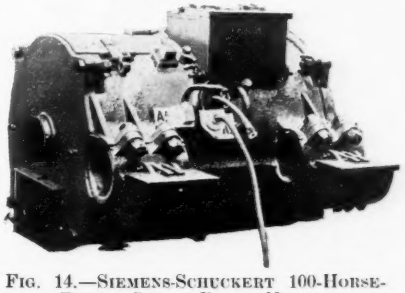


FIG. 14.—SIEMENS-SCHUCKERT 100-HORSE-POWER SINGLE-PHASE MOTOR.

and two 100-horse-power motors, based on a one-hour rating with a temperature rise of sixty-five degrees centigrade in still air; the middle axle is free to turn; this three-axle type of car being deemed advisable on account of the heavy grades and limited power available demanding light rolling stock.

The over-all dimensions of the motor cars are 44.3 feet by 8.2 feet by 14.1 feet, the wheel base being 13.1 feet.

There are two bow current-collectors per car (Figs. 2 and 3). These are pneumatically held against the trolley at a

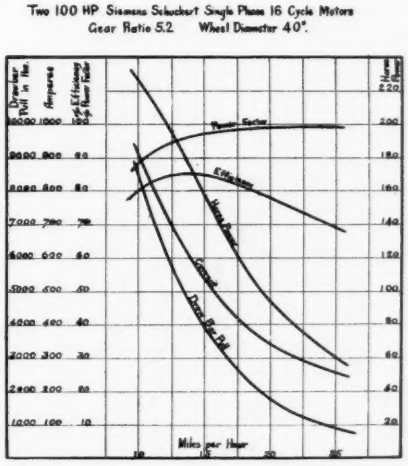



FIG. 15.—CHARACTERISTICS OF MURNAU-OBERAMMERGAU MOTOR CAR.

pressure of nine pounds and run in an almost vertical position, such that when the direction of travel is reversed they automatically turn over to a slightly trailing position by raising the trolley a little in so doing. In rough weather the wind pressure on the bows has to be counterbalanced by windboards placed below their axes in order to maintain contact on the trolley. Such an arrangement is illus-

trated on the freight locomotive (Fig. 4). The bow contact pieces are of aluminum and have a cross section of about three-quarters of a square inch, as shown in Fig. 13.

SEGREGATION OF PERCENTAGE, FIXED CHARGES.

| | Rolling Stock, Power-Station Machinery. | Lighting and Pumping System, Car Sheds and Equipment, Telegraph System. | Transportation and Trolley System Bonding. | Constructive Operation, Constructive Interest. | Power-Station Building. | Canal. | Land. |
|---|---|---|---|---|---|---|---|
| Life—years | 20 | 20 | 20 | 20 | 40 | 40 | .. |
| Scrap value—per cent. | 15 | 15 | 25 | .. | .. | 50 | 100 |
| [1]Interest | 4.20 | 4.20 | 4.20 | 4.20 | 4.20 | 4.20 | 4.20 |
| [2]Depreciation | 2.85 | 2.85 | 2.52 | 3.36 | 1.05 | 0.53 | .... |
| Taxes | 1.50 | 1.50 | 1.50 | .... | 1.50 | 1.50 | 1.50 |
| Risks | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | .... |
| Insurance | 0.50 | .... | .... | .... | 0.50 | .... | .... |
| [3]Discount on bonds | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| Total | 10.22 | 9.72 | 9.39 | 8.73 | 8.42 | 7.40 | 5.87 |

[1] $4\% \times \frac{100}{95} = 4.20\%$, allowing 5% discount on bonds.

[2] For 100% depreciation in 20 years @ 4% compound interest rate = 3.358%.
For 100% depreciation in 40 years @ 4% compound interest rate = 1.052%.

[3] $\frac{5\%}{20} \times \frac{.3853}{5} = 0.17\%$, assuming all bonds redeemable at end of 20 years.

Each reflector at the ends of the car contains two lamps, one red and one clear.

FIRST COST AND FIXED CHARGES.

| | | First Cost. | Rate. Per Cent. | Fixed Charges. |
|---|---|---|---|---|
| I. | Power-station, machinery | $34,000 | 10.2 | $3,500 |
| | Power-station, building | 15,000 | 8.4 | 1,300 |
| II. | Transmission and trolley system | 50,000 | 9.4 | 4,700 |
| III. | Canal | 38,000 | 7.4 | 2,800 |
| IV. | Bonding | 9,000 | 9.4 | 800 |
| V. | Lighting and pumping system | 7,000 | 9.7 | 700 |
| VI. | Car sheds and equipment | 7,000 | 9.7 | 700 |
| VII. | Land | 7,000 | 5.9 | 400 |
| VIII. | Telegraph system | 1,000 | 9.7 | 100 |
| | Total of Items I to VIII. | $168,000 | | $15,000 |
| | Assume two-thirds chargeable to passenger service | $112,000 | | $10,000 |
| IX. | Rolling stock | 50,000 | 10.2 | 5,100 |
| X. | Constructive operation, five per cent on Items I to IX. | 8,000 | 8.7 | 700 |
| XI. | Constructive interest equivalent to four per cent on one-half | 3,000 | 8.7 | 300 |
| | Grand totals | $173,000 | | $16,100 |

OPERATING LABOR COSTS.

| | Per Month. | Per Year. |
|---|---|---|
| One superintendent | $75 | $900 |
| Superintendent, house rental | 20 | 240 |
| One clerk | 30 | 360 |
| Four power-station operators | 120 | 1,440 |
| Power-station operators, house rental | 15 | 180 |
| Two repair men for transmission and trolley system | 60 | 720 |
| Six motormen and equipment repairers | 180 | 2,160 |
| Four conductors | 100 | 1,200 |
| Total | | $7,200 |
| Assume two-thirds chargeable to passenger service, or | | $4,800 |

These are put in operation in accordance with the direction of travel.

The motors are arranged permanently in parallel and are supplied through a transformer having one 130-volt and eight 17.5-volt steps, giving a maximum secondary voltage of 270 volts. The motors have the usual compensating windings, which effectively serve their purpose in the prevention of sparking, there being no signs of such at full load. The main controller is connected to a spark-extinguishing drum on the same shaft furnished with blowout magnets, thus preserving the contacts. The high-tension cutout has a fourfold interruption, automatically closing as soon as the controller comes to the first position. It may be released (1) by turning back the controller, (2) automatically by an overload, (3) by a special trip switch, the latter means being desirable in case of an accident.

The air-compressor is driven directly from the car axle, making its action certain whenever the car is in motion.

Fig. 14 is a photograph of one of the motors, and Fig. 15 gives the characteristics of a motor-car, from which it will be seen that the power-factor is upward of ninety-five per cent for the motors alone, although only an average of eighty per cent for the whole system, as shown in Fig. 6.

The cost of the rolling stock is as follows: Four motor-cars at $8,750, $35,000; four passenger trailers at $2,500, $10,000; three baggage trailers at $1,750, approximately, $5,000; total, $50,000.

The writer thanks the Siemens-Schuckert Company and the Munich Local Railway Company for the courtesies extended to him on the occasion of his visit and for information supplied.

COST OF MAINTENANCE AND REPAIR MATERIAL FOR FIXTURES.

| | |
|---|---|
| Power-station machinery, 4% on first cost | $1,360 |
| Power-station building, 1½% of first cost | 230 |
| Transmission and trolley systems, 3% of first cost | 1,500 |
| Canal, 1¼% of first cost | 570 |
| Bonding, 1½% of first cost | 140 |
| Lighting and pumping system 4% of first cost | 280 |
| Car sheds and equipment, 2% of first cost | 140 |
| Telegraph system, 2% of first cost | 20 |
| Total | $3,740 |
| Assume two-thirds chargeable to passenger service, or | $2,500 |

COST OF MAINTENANCE AND REPAIRS TO ROLLING STOCK.

| | Cost per 1,000 Car-Miles. For Trailers. | For Motor-Cars. |
|---|---|---|
| Supplies: | | |
| Controller parts and bow contacts | .... | $0.3 |
| Gears and motor bearings | .... | 0.1 |
| Brushes | .... | 0.1 |
| Brake-shoes | $1.0 | 1.0 |
| Oil, waste and grease | 0.3 | 0.4 |
| Bearings | 0.3 | 0.4 |
| Wheels | 0.4 | 0.6 |
| Total | $2.0 | $2.9 |
| Repairs: | | |
| Motors (less bearings) | .... | $1.0 |
| Compressors | .... | 0.4 |
| Bodies | $2.0 | 2.0 |
| Brakes | 0.7 | 0.9 |
| Trucks | 0.3 | 0.5 |
| Total | $3.0 | $4.8 |
| Total—Supplies and repairs | $5.0 | $7.7 |
| Annual Cost: | | |
| Miles per year (14.7 x 14 x 365) | 75,000 | 75,000 |
| Cost per year | $380 | $580 |
| Cost per year—motor-cars and trailers, approximately | $1,000 | |

ANNUAL PERFORMANCE OF EQUIPMENT.

| Type of Car. | Aver. Tons. | Aver. Seats. | Miles/Year. | Ton-Miles. | Seat-Miles. |
|---|---|---|---|---|---|
| Passenger motor-car | 31 | 46 | 37,500 | 1,162,500 | 1,725,000 |
| Combination motor-car | 31 | 28 | 37,500 | 1,162,500 | 1,050,000 |
| Passenger trailer-car | 13 | 53 | 37,500 | 487,500 | 1,987,500 |
| Baggage trailer-car | 13 | .. | 37,500 | 487,500 | ..... |
| Totals, approximately | | | | 5,300,000 | 4,800,000 |

SUMMARY—CHARGEABLE TO PASSENGER SERVICE.

| | |
|---|---|
| First cost | $173,000.00 |
| Annual cost | 24,400.00 |
| Cost per ton-mile | .74 |
| Cost per seat-mile | .50 |

## Meeting of the National Conference on Standard Electrical Rules.

The National Conference on Standard Electrical Rules was held at the Edison Auditorium, New York city, on Friday, March 27. The meeting was called to order by W. H. Blood, Jr., chairman of the conference, and the announcements were made by the secretary, Dr. C. J. H. Woodbury.

There was not much brought before the conference, a brief discussion taking place on the suggestion of E. H. McCleary, president of the National Electrical Contractors' Association, that a motion prevail suggesting to the Electrical Committee of the Underwriters' National Electric Association that Rule 24p of the National Electrical Code be so amended as to allow more than eight or nine conductors in a conduit, subject to the supervision of the inspectors having jurisdiction. In many cases, particularly where risers were used in modern buildings, it would lead to economical advantage if this were provided. This motion was carried.

The subject of grounding the neutral of three-phase systems was also discussed, and it was the sense of the meeting that if the proper suggestions were made for grounding, that when the rule which is now being formulated for incorporation in the National Electrical Code was adopted it should be mandatory.

Both Mr. Blood and Dr. Woodbury were elected to serve in their respective offices for the ensuing year, and a resolution of thanks was tendered to the New York Edison Company for its courtesy in furnishing a meeting place.

## FUSE PHENOMENA.[1]

BY ALFRED SCHWARTZ AND W. H. N. JAMES.

### THE PURITY OF THE METAL.

With regard to this factor, the importance of employing a material which can easily be obtained of standard composition is generally understood; but, notwithstanding this, a very large amount of alloy wire and strip is still used, the composition of which is a very uncertain quantity. It is true that many of these metals have lower melting points than those of the pure metals in use as fuses, but this does not outweigh the advantage which a pure metal such as copper possesses of constancy of composition.

### THE MELTING POINT.

The fire risk with metals of low melting point is due to the scattering of

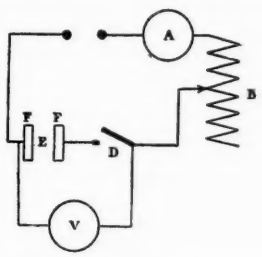



FIG. 1.—DIAGRAM OF ARRANGEMENTS FOR SHORT-CIRCUIT TESTS.

A. Ammeter. B. Adjustable low resistance D. Main switch. F. Fuse terminals. V. Voltmeter for circuit voltage.

molten particles when the fuse blows, or to the persistence of the arc across the terminals. With metals of high melting point there is an additional risk due to the fuse becoming red hot before fusion.

As special points in connection with the fire risk, the liability of some metals, such as zinc, to burn in air at the temperature of disruption must be considered; and with enclosed fuses fitted with indicator wires, it must be borne in mind that this wire practically forms an open fuse of small capacity; and experience has shown that the flash from such an indicator is sufficient to ignite combustible material in the vicinity.

Further, with enclosed fuses, unless hermetically sealed or provided with special arrangement, referred to hereafter, for preventing the ejection of molten metal, both flame and molten metal may issue from the ends.

### THE MASS OF METAL REQUIRED FOR A GIVEN SERVICE.

This is concerned with the fire risk, the time element, and in enclosed fuses with the diameter of the jacket employed.

[1] Abstract from a paper read before the Institute of Electrical Engineers of Great Britain.

The relative quantities of heat in fuses of various metals at the moment of melting are given in Table I.

TABLE I.

RELATIVE QUANTITIES OF HEAT AT THE MOMENT OF MELTING IN FUSES OF VARIOUS METALS, BUT OF THE SAME NORMAL FUSING CURRENT.

| Metal. | Approximate Relative Quantity of Heat in Fuse of 20-Ampere Capacity at Moment of Fusion. |
|---|---|
| Copper | 1.00 |
| Aluminium (with spring attachment) | 1.20 |
| Silver | 0.90 |
| Tin | 1.26 |
| Zinc | 1.53 |

Although the quantity of heat in the fuse at disruption may be considered as some criterion for selecting a metal from the fire-risk point of view, yet in our view this consideration is outweighed by others, such as the capacity of the metal for maintaining an arc, the surface tension of the molten metal as influencing the way in which it segregates into globules, the behavior of the globules of metal after disruption as to whether they burn in air or not.

Further, the boiling points of metals with low melting points, such as lead, tin and zinc, are in the neighborhood of 1,000 degrees centigrade, and it is certain that many of the globules of these metals, which are scattered on disruption, approximate to this temperature.

In general, it may be taken that the mass of metal in the fuse should be kept as small as possible for open-type fuses; for enclosed fuses this point has to be considered in connection with the temperature which the jacket material will stand, as the metals with small mass necessarily have a high melting point and will attain red heat before fusion. In the screened shunted type of fuse it would seem possible to employ a metal with large mass and low melting point for the main fuse, as this will melt quite quietly, the break being made on the shunt, which is of high resistance, and is enclosed or protected.

For fuses of large capacity this type is worthy of more attention than has hitherto been paid to it.

The terms "short-circuit" and "dead short-circuit" are used very loosely, and as the amount of current flowing on short-circuit largely affects the behavior of the fuse on disruption it becomes necessary to define it more strictly. This can be done by specifying the drop in volts in the leads with the normal fusing current of the fuse under test flowing; thus a three per cent drop in volts would allow of a short-circuit current equal to thirty-three times the normal fusing current of the fuse under test, a ten per cent drop of ten times the normal fusing current, and so on.

A diagram of the testing arrangements employed by us is given in Fig. 1. The method of working is as follows: Across the terminals F in lieu of the fuse was placed an adjustable resistance E sufficient to carry the normal fusing current of the fuse under test. For large currents this resistance may be of such size as to carry one-half or one-third of the normal fusing current, the drop in this case being adjusted to one-half or one-third of the drop that would be obtained with the full normal fusing current.

The switch D was then closed and the resistance E adjusted, so that the ammeter A read the normal fusing current of the fuse under test.

The resistance B was adjusted so that the difference in readings on the voltmeter V with the switch D open and closed was the required drop. It is necessary that the resistance B should be small compared to the resistance E; an alteration in the value of B will alter the current read at A, and will necessitate a slight readjustment of E.

The resistance E was now removed and replaced by the fuse.

The three per cent drop in pressure referred to has been found to be representative of the conditions likely to be met with in house services for main and distribution-board fuses.

As already stated, the minimum length of break was taken as the least length at which no damage was done to the terminals on short-circuit, the resistance of the circuit being such as to give a three per cent drop with the normal fusing current flowing.

Under these conditions a length is obtained at which there may be said to be "no arc," although, strictly speaking, an arc results every time a fuse blows, but in the above-mentioned case its duration is so short that no damage is done to the terminals. This length will be referred to hereafter as the "minimum no-arc length."

In carrying out experiments on the minimum no-arc length it was found that there was a greater tendency for an arc to form across clean, freshly fused surfaces than across dirty surfaces, and since in these experiments the object was to get an arc if possible, short lengths were first taken with which an arc was formed. The length of fuse was then gradually increased until a point was reached at which

at least three successive fuses of the same length were blown without an arc resulting. Under these circumstances the surface of the terminals for each new length of fuse experimented with was a clean one across which an arc had recently taken place.

If, instead of proceeding as above, a long length is taken such that on blowing no arc to the terminals takes place, and this length is gradually reduced until an arc is formed, a much shorter "minimum no-arc length" will be obtained, since in this case each fresh length is tried with a dirty terminal surface.

We find that for copper wires of twenty amperes' normal fusing current and upward on a 220-volt circuit the minimum no-arc length increases slightly as the drop in pressure in the circuit is reduced.

On the other hand, for smaller copper wires (Nos. 33 and 29 S. W. G.) in open-type cutouts the minimum no-arc length seems to be larger with a short-circuit current of ten times the normal fusing current than with a current thirty-three times the normal fusing current.

The minimum no-arc length for open-type fuses of a given metal increases with the capacity of the fuse, but not proportionally. The curve connecting the minimum no-arc length and the normal fusing current for open-type copper fuses on 220-volt non-inductive circuit (*i. e.*, with the inductance due to the generator and cables only) with short-circuit currents of thirty-three times normal fusing current is given in Fig. 2, Curve A.

These curves follow a law of the character of $D = A + B\ (N.\ F.\ C.)^{n}$, where

D = minimum no-arc length;

N. F. C. = normal fusing current;

A, B, and $n$ = constants depending on the metal employed and on other factors ($n$ being less than 1).

With enclosed fuses the minimum no-arc length increases with the capacity of the fuse much in the same way as in the open type. The results for copper fuses up to fifty amperes on a 220-volt non-inductive circuit are shown graphically in Fig. 2, Curve E.

The variation of minimum no-arc length with the pressure of the circuit was determined by experiments carried out at pressures of 110 and 220 volts on open and enclosed-type fuses. The results showed that for open-type fuses the increase in length of the minimum no-arc length is at least in proportion to the increase in the circuit pressure for the ranges given.

The curve connecting the minimum no-arc length with the normal fusing current for copper wires in open-type cutouts is given in Fig. 2, Curve A, for short-circuit currents of thirty-three times normal fusing current and ten times normal fusing current, whichever gave the greater length.

TABLE II.

MINIMUM NO-ARC LENGTH FOR OPEN-TYPE FUSES OF COPPER AND ZINC ON 220-VOLT NON-INDUCTIVE CIRCUIT. SHORT-CIRCUIT CURRENT EQUALS THIRTY-THREE TIMES NORMAL FUSING CURRENT.

| Fuse Metal. | Normal Fusing Current in Amperes in Air. | Minimum No-Arc Length in Inches. Zinc. | Copper. |
|---|---|---|---|
| Zinc | 26.0 | 2.85 | 4.2 |
| Copper | 27.0 | | |
| Zinc | 45.0 | 3.05 | 4.5 |
| Copper | 41.5 | | |

Under the same conditions in open-type fuses the minimum no-arc length for zinc is decidedly less than that for copper.

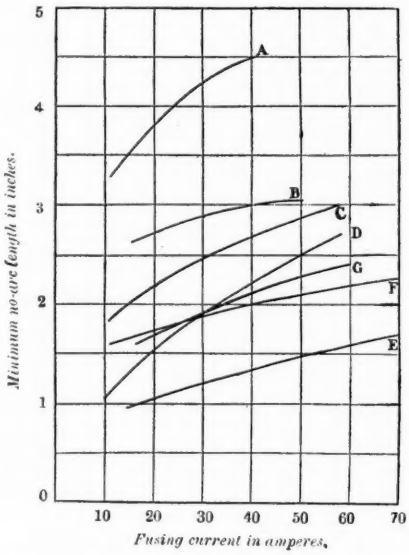



FIG. 2.—MINIMUM NO-ARC LENGTH AND NORMAL FUSING CURRENT.

A. Copper wire in air. B. Zinc strip in air. C. Copper wire in tubular holder. D. Copper wire with asbestos partition at centre. E. Copper wire enclosed with Calais sand filling. F. Copper wire enclosed on inductive circuit. G. Zinc strip enclosed on non-inductive circuit

All the above on 220-volt circuit. A to E, non-inductive; F, inductive (0.023 henry).

The results of about twenty experiments in each case are given for the two metals in question in Table II.

Zinc blows fairly cleanly; the molten metal is not scattered far, but occasionally some globules show a tendency to continue to burn in air where they fall. On the whole it is a good material from a short-circuit point of view.

Tin in open-type cutouts with short-circuit currents of ten times the normal fusing current behaves very much like copper with short-circuit currents limited to two or three times the normal fusing current; that is to say, it blows softly and quietly, and it is difficult to state from visual observation when arcing takes place.

It may be taken that the damage to terminals with tin in lengths commonly employed is slight with short-circuit currents of ten times the normal fusing current.

With twenty or thirty-ampere fuses and short-circuit currents of thirty-three times normal fusing current there is, however, a great display of fireworks, accompanied by copious fumes, and with the lengths commonly used severe damage to terminals is likely to ensue.

With enclosed fuses the minimum no-arc length was found to be somewhat greater for zinc than for copper; this is due to the greater mass of metal involved for a fuse of a given capacity and to the molten metal being confined by the filling, and possibly also to the metal vapor not being so quickly oxidized as when the fuse is in air. As already stated, in open-type cutouts this effect is reversed, the zinc giving the shorter minimum no-arc length. The following examples given in Table III for copper and zinc in enclosed fuses are typical:

TABLE III.

MINIMUM NO-ARC LENGTH FOR COPPER AND ZINC IN ENCLOSED FUSES WITH CALAIS SAND FILLING 220-VOLT NON-INDUCTIVE CIRCUIT. SHORT-CIRCUIT CURRENT EQUALS THIRTY-THREE TIMES NORMAL FUSING CURRENT.

| Fuse Metal. | Normal Fusing Current in Amperes in Air. | Minimum No-Arc Length in Inches. |
|---|---|---|
| Zinc | 25 | 1.8 |
| Copper | 27 | 1.3 |
| Zinc | 45 | 2.2 |
| Copper | 43 | 1.6 |

The minimum no-arc lengths for enclosed fuses of copper and zinc under various conditions and for fuses up to fifty amperes are given in Fig. 2. In inductive circuits zinc gives lengths about twenty per cent greater than those given which are for non-inductive circuits. Tin gives length rather greater than zinc in each case.

That the different metals behave in a characteristic manner on fusion with regard to the duration of the current rush on short-circuit, the tendency of the arc to persist, and the inductive pressure rise on breaking the circuit, may be seen from the oscillograms given in Fig. 3.

These oscillograms have been selected from a large number obtained for various metals, and are typical of the metals named. The following is a brief résumé of the points observable from the oscillograms:

Copper—Fig. 3A, Open-type, 110-Volt Inductive Circuit—The inductive pressure rise is usually only moderate, as the arc persists for a definite but short time.

Fig. 3B, Open-Type, 220-Volt Inductive Circuit—The arc persists for a considerably longer period; the voltage rise is fairly small and irregular. The cur-

rent rush does not rise to the value determined by the resistance of the circuit owing to the quick action of the fuse.

Fig. 3C, Enclosed-Type, 220-Volt Inductive Circuit—The double rise shown here is very characteristic of copper.

Tin—Fig. 3D, Open-Type, 110-Volt Inductive Circuit—The inductive pressure rise is usually higher than that of copper, and the duration of the arc is less. Occasionally a considerable voltage rise is obtained (Fig. 3E).

Silver—Fig. 3E—Behaves very similarly to copper, the duration of the arc being slightly longer and the inductive pressure rise about the same.

Aluminum—Fig. 3I, 110-Volt Inductive Circuit—The inductive voltage curve is usually very peaked in shape, its maximum being higher than that of tin.

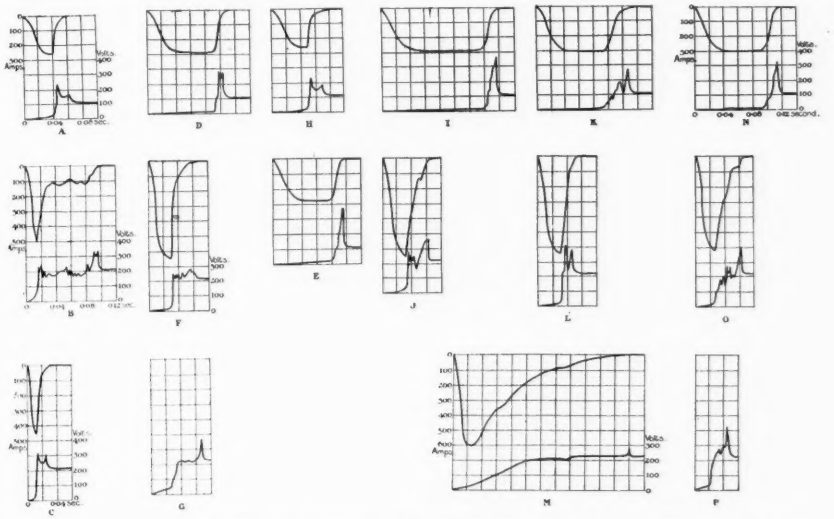


FIG. 3.—OSCILLOGRAPH CURVES SHOWING BEHAVIOR (CURRENT AND PRESSURE) OF ARCS WITH DIFFERENT KIND OF METALS.

Sometimes a double peak is obtained, and in these cases the voltage rise is about the same as for tin.

Fig. 3J, 220-Volt Inductive Circuit—The voltage rise is small, being less than in the 110-volt case, as the arc persists for a considerably longer period.

Cadmium—Fig. 3K, 110-Volt Inductive Circuit—The inductive voltage curve is usually very irregular, probably owing to the instability of the arc; its maximum is rather greater than that for zinc, and it takes a considerable time to die away.

Fig. 3L, 220-Volt Inductive Circuit—Resembles aluminum, and although the inductive pressure rise is rather greater than with copper, it is better than copper from the point of view of the duration of the arc.

Fig. 3M—The gradual fall in the current after fusion and the gradual rise in pressure to the normal circuit voltage with the small final inductive rise seems to indicate that the tube formed in the Calais sand filling while hot was acting as a conductor as already referred to.

Zinc—Fig. 3N, Open-Type, 110-Volt Inductive Circuit—Like aluminum, gives rise to a high inductive voltage rise; the form of the curve suggests instability of the arc.

Fig. 3O, Open-Type, 220-Volt Inductive Circuit—The curves of inductive pressure rise are irregular and show the highest voltages in the series.

Fig. 3P—Comparing this with Fig. 3E for copper and Fig. 3G for tin in enclosed fuses, it will be seen that copper breaks the circuit more quickly than either of these two.

A consideration of these oscillograms shows that inductive pressure rises of as much as four times the circuit pressure may be met with in moderately inductive circuits. In the experiments with the oscillograph a choking-coil of very low resistance was inserted in series with the fuse; the value of the inductance was 0.023 henry with the normal fusing current (twenty-seven amperes) of the fuses under test flowing in the circuit. The value of the inductance would, of course, be less with short-circuit current flowing on account of the saturation of the core of the choking-coil.

It was found that the minimum no-arc length was increased on circuits with an inductance of 0.023 henry as against circuits in which the inductance was only that due to that of the generator and leads; the results are shown in Fig. 2. On non-inductive circuits the tests showed comparatively small voltage rises, and these were of short duration.

Where present, the voltage rise occurs at two definite periods: firstly, when the current commences to fall, and secondly, when it ceases. The tests were carried out on circuits of moderate inductance, because the pressure curves thus obtained gave more information as to the working of the fuse than with non-inductive circuits.

In order to test the magnetic blowout effect obtainable from the circuit conductors, the leads to the fuse terminals were bent through a right angle.

It was found with this arrangement that the minimum no-arc length for open-type fuses could be very considerably reduced. For instance, with a twenty-seven-ampere copper fuse on a 220-volt circuit with leads bent up for a distance, D, of four inches, the minimum no-arc length was 0.7 inches, as against a length of 3.6 inches with the circuit cables entering the terminals in the ordinary way. Short-circuit current equals thirty-three times normal fusing current. The length was not materially increased with D reduced to one inch, and even when an arc was formed it was of short duration and little damage was done to the terminals. This magnetic blowout arrangement might well be taken advantage of in practice, as has already unwittingly been done with some forms of knife-blade terminals, and terminals in which the cables enter from the back in contradistinction to the sides.

It was found that the minimum no-arc length diminishes as the terminals are increased in size, and this effect is greatest with small fuses.

This effect is probably not so much due to the cooling of the ends of the fuse by conduction, which for short-circuit currents of thirty-three times normal fusing current may be considered negligible, the whole length of wire being almost instantly disrupted, as to the cooling of the arc vapor by the terminals. This cooling, taking place along a transverse section of the arc, introduces at each end a small section of high resistance which breaks down the arc.

The formation of a slag tube around the fuse on disruption would seem to depend on the character of the filling employed, and to some extent on the character of the fuse metal. In general, silicious fillings favor the formation of these tubes, whereas cretaceous or chalky fillings do not.

Metals with a high melting point would at first sight seem to favor this formation, but it must be borne in mind that although the melting point of a metal such

as tin is low, yet the temperature of the arc following disruption may be, and probably is, as high as with metals of a higher melting point.

Apart from the formation of tubes and the absorption of moisture by the filling, the chief characteristics which differentiate the various materials used for fillings are the degree of fineness of the particles and the degree of tightness of the packing; the specific heat and thermal conductivity of the filling only influence the results indirectly, in that they affect the normal fusing current of the fuse.

The normal fusing current for a given fuse is greater when enclosed and surrounded by a filling than when free in air from terminal to terminal. Experiments with a copper wire (normal fusing current in air twenty amperes) illustrating this point are given in Table IV.

TABLE IV.

INCREASE IN NORMAL FUSING CURRENT FOR FUSES ENCLOSED IN A PORCELAIN TUBE OF THREE-EIGHTH-INCH INTERNAL DIAMETER WITH VARIOUS FILLINGS.

| Nature of Filling. | Normal Fusing Current in Amperes. |
|---|---|
| Air (open fuse) | 20 |
| Trent sand (loosely packed) | 22 |
| Trent sand (tightly packed) | 25 |
| Calais sand | 30 |

Experiments showed that the normal fusing currents increase relatively in the same way as the rates of conduction of heat through the fillings, and that it is only a comparatively thin layer of filling around the fuse which exerts any considerable influence on the fusing current, and further, that this effect is due chiefly to the conductivity of the filling for heat.

It is probable that with tubes of very small diameter and with a small amount of filling the normal fusing current would not be increased so much as in cases given in Table IV. Three experiments with a No. 27 S. W. G. copper wire, normal fusing current in air twenty amperes, when passed through a clay tobacco-pipe stem, gave a mean normal fusing current of twenty-eight amperes. The same size wire when passed through a braided asbestos tube had a normal fusing current of twenty-two amperes when the texture of the braiding was open, and twenty-five amperes when the texture was very close.

The effect of the size of the particles of the filling on the duration of the arc was tested. It was found that the more finely the material of the filling is divided the more quickly was the arc extinguished. This result is supported by a large number of oscillograms with various powders, both coarse and fine. The fine powders seem to be more effective in repressing the arc than the coarse ones, owing to their interstices being smaller and less air being included. This effect is linked with the degree of tightness with which the filling is packed. With the coarse filling the circuit was sometimes opened satisfactorily and sometimes irregularly.

Experiments were carried out with fillings of various degrees of fineness packed both tightly and loosely, and it was found that with fine powders the minimum no-arc length was shorter for both tight and loose packing than with coarse powders. This points to the presence of air spaces in the filling due to the size of the particles of the filling being large, as having an adverse influence on the minimum no-arc length, since the tightness of the packing has but little influence in reducing the air spaces with coarse powders.

With fine powders loosely packed there is a good deal of noise on disruption if the jacket is not hermetically sealed, and the filling is much blown about and some of it is compressed by the explosion against the inside of the tube. Loose

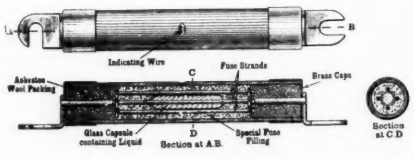



FIG. 4.—"KOOLARK" FUSE.

fillings are therefore not to be recommended; and further, when used vertically, as is nearly always the case, the filling will gradually settle together more closely, leaving a portion of the wire at the top end of the fuse exposed.

In order further to investigate the influence of tight packing, a series of experiments was carried out with fuse wires set in plaster of Paris. This practically amounts to a fuse with a very tightly packed filling; such fuses give a quick break, with a consequent high inductive pressure rise on inductive circuits. In general, these fuses blow very quietly, provided that the plaster covering does not crack or rupture; when this occurs bad arcing frequently results, and a loud report is produced. It is essential that the whole length of the fuse wire should be embedded in the plaster. A containing envelope or jacket, even if only of slight mechanical strength, is essential for plaster fillings.

With enclosed fuses in general the jacket affords considerable protection from moisture, and the filling materials usually employed do not cake or cohere. Moisture in the filling, however, is not unusually present in commercial forms of fuses in red fibre jackets, as it exudes on tests when the fuse becomes hot. The closing of the vent holes of such fuses with a disc of glazed paper does not seem to be a very efficient means of preventing the ingress of moisture in damp situations.

Experiments were made with Calais sand as representing a silicious non-absorptive filling. These seemed to show that no very marked effect is produced on the action of the fuse by moderate amounts of moisture in the filling, but that when in excess—with 12.8 per cent of water the filling was almost "sloppy"—it produced irregularity of action in the fuse.

Experiments were then made with a filling of Trent sand; this is much finer in texture than Calais sand, and absorbs water freely, ultimately forming a mud. As the percentage of moisture in the Trent sand was increased, the action of the fuse became irregular, but with the moderately wet sand tightly packed a quick break and high voltage rise resulted. In this series the arc was broken very quickly, due probably to its being cooled by the evaporation of the water. This point is of interest in connection with a type of fuse recently placed upon the market in which a special liquid enclosed in a small glass tube is disseminated throughout the filling when the fuse is subjected to a short-circuit. When the fuse blows with a moderate overload the glass tube is not broken and the filling remains dry. The construction of this fuse is shown in Fig. 4.

Although moisture in the filling may not very seriously affect the action of the fuse as far as the suppression of the arc is concerned, its presence in enclosed fuses is not at all desirable, as it would certainly lead to corrosion and electrolytic troubles, particularly if a contact difference of potential exist between the fuse and the wire or lug connecting it to the fuse contacts.

*(To be concluded.)*

## Oklahoma Electric Light, Railway and Gas Association.

The second annual convention of the Oklahoma Electric Light, Railway and Gas Association will be held at Guthrie, Okla., on May 25, 26 and 27. The officers of the association are: F. H. Tidnam, president, Oklahoma City; first vice-president, E. C. Reynolds, Sapulpa; second vice-president, J. H. Merrill, McAlester; third vice-president, F. J. Bedford, Lawton; treasurer, W. J. Dibbins, Guthrie; secretary, Galen Crow, Guthrie.

## THE RELATIVE VALUES OF GASOLENE AND ALCOHOL AS PRODUCERS OF POWER.

TESTS MADE BY THE TECHNOLOGIC BRANCH OF THE UNITED STATES GEOLOGICAL SURVEY.

The Technologic Branch of the United States Geological Survey, under the direction of J. A. Holmes, has recently completed an elaborate series of tests on the relative value of gasolene and alcohol as producers of power. The tests, over two thousand in number, probably represent the most complete and exact investigation of the kind that has been made either in this country or abroad, and includes much original research work.

Professor R. H. Fernald, engineer in charge of the gas-producer section and professor of mechanical engineering in the Case School of Applied Science, Cleveland, Ohio, was in general charge of the tests. R. M. Strong, formerly connected with the engineering department of Columbia University, had personal supervision of the work. He was assisted by a corps of specially trained men.

These tests were conducted at the fuel-testing plant of the Geological Survey, at Norfolk, Va., and show the following results in regard to the comparative fuel consumption of seventy-three-degree specific gravity gasolene and commercial completely denatured alcohol, per unit of power.

Correspondingly well-designed alcohol and gasolene engines when running under the most advantageous conditions for each will consume equal volumes of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel consumption values thus obtained gives a like figure for eight-tenths (0.8) of a pint per hour per brake horse-power for gasolene and alcohol.

Considering that the heat value of a gallon of the denatured alcohol is only a little over six-tenths (0.6) that of a gallon of the gasolene, this result of equal fuel consumption by volume for gasolene and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by Continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the government fuel-testing plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The air was not preheated for the above tests on alcohol and gasolene, and the engines were equipped with the ordinary types of constant-level suction lift and constant-level pressure spray carbureters. Many special tests with air preheated to various temperatures up to 250 degrees Fahrenheit, and tests with special carbureters were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol plus ten parts methyl alcohol plus one-half of one part benzol and corresponds very closely to ninety-four per cent by volume or ninety-one per cent by weight ethyl alcohol (grain alcohol).

Eighty per cent alcohol (alcohol and water) for use in engines of the present types would have to sell for at least fifteen per cent less per gallon than the denatured alcohol in order to compete with it. The minimum consumption values in gallons per hour per brake horse-power for eighty per cent alcohol is approximately 17.5 per cent greater than for the denatured alcohol used or for gasolene. A series of tests made with alcohol of various percentages by volume ranging from ninety-four per cent to fifty per cent showed that the minimum consumption values in gallons per hour per brake horse-power increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency or increase in consumption referred to pure alcohol is, however, comparatively slight from 100 per cent alcohol down to about eighty per cent alcohol. Within these limits it may be neglected in making the calculations necessary to compare the minimum consumption values for tests with different percentages of alcohol.

With suitable compression, mixtures of gasolene and alcohol vapors (double carbureters) gave thermal efficiencies ranging between that for gasolene (maximum 22.2 per cent) and that for alcohol (maximum 34.6 per cent), but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake horse-power and the low calorific value of the fuel, which for the gasolene was 19,100 British thermal units per pound and for the denatured alcohol was 10,500 British thermal units per pound.

As has been previously published, alcohol can be used with more or less satisfaction in stationary and marine gasolene engines and these gasolene engines will use from one and one-half to twice as much alcohol as gasolene when operating under the same conditions. The possibilities, however, of altering the ordinary gasolene engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder head and valve arrangement is ordinarily not sufficient, nor are the gasolene engines usually built heavy enough to stand the maximum explosive pressures, which often reach six and seven hundred pounds per square inch. With the increase in weight for the same-sized engine designed to use alcohol instead of gasolene, comes an increase in maximum horse-power of a little over thirty-five per cent, so that its weight per horse-power need not be greater than that of the gasolene engine and probably will be less.

The work was taken up to investigate the characteristic action of fuels used in internal-combustion engines with a detailed study of the action of each fuel (gasolene and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment. These variables were isolated, so far as possible; their separate and combined effects were determined, worked out under practical operating conditions, and lead up to the conditions required for minimum fuel consumption.

Many of the tests of internal-combustion engines have been made, but most of them, especially in this country, were by private concerns, for a specified purpose, and the results are not generally available. Furthermore, as is generally recognized by those familiar with gas and especially gasolene-engine operation, the conditions influencing engine performance are so numerous and various as to make the value of off-hand comparison very limited and oftentimes misleading, exact comparisons only being possible under identical conditions or with reference to the actual known differences in all conditions that influence the results.

With a view to supplying the continually increasing demand for more complete and exact information concerning the operation and design of gasolene and alcohol engines, and to assist the government and others interested in the larger and more general internal-combustion-engine problems, this investigation was made.

# REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

### The Engelberg-Lucerne 25,000-Volt Overhead Transmission.

The high-tension transmission line between Obermatt and Engelberg possesses some interesting and unusual features. The main overhead line consists of nine copper conductors supported on a single line of steel lattice poles. It runs from the power station near Obermatt to a substation at Steghof, and is 16.7 miles long. Three of these conductors supply three-phase power to Lucerne; three others, from a three-phase circuit, to the substation at Stansstad; two of the remaining conductors form a single-phase lighting supply for Lucerne; the remaining conductor is held in reserve and can be used for any of the three circuits. The line is intercepted at three points for taking off power for surrounding districts, and at these points all nine conductors are carried into massive stone towers which contain the section switch gear and the transformers for local supply. The lattice poles which support the line are embedded in concrete foundations and are spaced 180 feet apart. The cross-arms are of steel and support two vertical beams of impregnated oak, upon which the insulators are fixed by means of U-shaped iron pins. The conductors are forty inches apart. Each pole weighs about 750 pounds and costs $55. The cost of erecting the poles was $60 each, including the material for the foundations. The poles are earthed by a copper wire which is connected to each electrically and runs the whole length of the line, and at every tenth pole is connected to a copper plate ten feet square, buried at the foot of the pole. The telephone wires for the power line are carried on the same poles and are crossed every 300 yards. Between the Stansstad substation and one at Hergiswyl the transmission line runs along the side of the road at the edge of Lake Lucerne. On one side is the rocky slope of the Lopperberg and on the other is the edge of the lake, which rapidly deepens. On this side of the road there is a line of telegraph and telephone wires which could not be moved, hence, steel brackets were built out about twenty feet over the lake and on the end of these the lattice poles are mounted. At this point of the route the average span has been increased to 360 feet so as to reduce the number of poles. —*Abstracted from Electrical Engineering (London), March* 12.

### Bulk Supply in Greater London.

The authors of this communication, J. H. Bowden and F. Taite, having faced the problem of either arranging for a bulk supply for their distributing system or carrying out further extensions to meet the exigencies of the coming winter's demand, obtained offers for such supply from three power companies. The terms offered differed in such a way that a thorough analysis of them was necessary in order to determine which would be the most economical. The rates ranged from a charge of $21.25 per kilowatt of maximum demand to $18.75, and the charge for the energy supplied from one cent to 0.66 cent a kilowatt-hour. That company quoting the highest price for the minimum demand also quoted the highest price per unit used and included a proviso for increasing the charge should the price of coal increase. In two of the offers the energy was to be measured at the supply company's switchboard, and in the third at the substation of the distributing company. Hence, it was necessary, in comparing the offers, to consider the efficiency of transmission and transformation. The authors then assume a maximum demand of 500 kilowatts and a load-factor of twenty-three and one-half per cent, and under this condition estimate that the most favorable offer would bring the cost per unit sold to 1.92 cents. To this should be added the taxes, management charges and distribution costs, which would bring the total cost up to 2.454 cents per kilowatt-hour. As the estimated income per unit for the period for which the supply was to make provision was 2.986 cents, the insignificant amount of 0.532 cent per kilowatt-hour remains for interest charges on substation, land, buildings, converting machinery, low-tension mains, services, meters, etc. This was considered to be inadequate. Furthermore, the annual cost of the undertaking would have been fixed for a term of years, during which the average price received for power would probably fall, so that even should a small profit be realized at the present time, there would be a heavy loss at a future date. The authors then estimate the cost of supplying this energy by extending the present system. The present cost for the energy is 2.94 cents per kilowatt-hour; the cost for the contemplated extension is estimated at 1.804 cents per kilowatt-hour, and the total cost is estimated to be 2.59 cents. Since the lowest cost of energy from an outside source would not be less than 2.454 cents per kilowatt-hour, and bearing in mind the price of coal, the subject of fluctuation will probably decrease considerably. The company would probably profit considerably by making the extension, particularly as the estimated cost of this power has been made high intentionally. The analysis shows that future offers of supplying bulk will have to be made in different terms in order to be acceptable to the distributing company.—*Abstracted from the Electrical Review (London), March* 13.

### Engineering Nomenclature.

This subject is divided by R. H. Smith into three distinct divisions. One is that of algebraic symbolism; another is uniformity of technical names to be used throughout the English-speaking world, and the third is the provision of simple, short names for the units of different classes of magnetic and other quantities. There have been many discussions of late on the first division of this subject, and the great difficulty of coming to some agreement is due to the desire to employ a symbol which will in some way suggest the unit which it represents; but since these units have different names in the different languages, it is impossible in many cases to select a symbol equally suggestive of all these names. Probably the best that can be done at the present time will be to settle upon symbols to be employed by those speaking English and for those terms used internationally. Due to the limited number of alphabetical symbols, it will be necessary in many cases to make use of double or more complicated symbols. By using, at the most, two letters, and distinguishing between capitals and small letters, there are about 2,750 possible pairs of symbols. By distinguishing between Roman and italic letters, nearly 11,000 combinations are obtain-

able. Such combinations would, however, need to be very arbitrary, and but few of them would be at all suggestive of the thing symbolized. By adding the Greek letters and omitting the italics, 5,800 combinations are available, which is more than sufficient for our needs. The difficulty, of course, will be to decide upon the proper symbols for the various quantities. Regarding the second division of the subject, the author points out the non-uniformity existing in England, which is apparently considerably greater than in this country. This difference is so great that it is not uncommon for a Scotchman to be unable to understand a Lancashireman, or a Yorkshireman a Londoner, although all four use precisely the same implements. Compulsory pressure should be put upon the compilers of technical books to force them to avoid all but the accepted designation. The third division of this subject is thought to be that most nearly ripe for immediate action. It is time that simple names for the units of frequently used quantities should be adopted, and these should be names having general rational significations and not restricted by reference to any one particular set of units. In reasoning about areas, it is inconveniently irrelevant to speak of square feet or square centimetres. The generality of the reasoning is only indicated by speaking of units of area, but there is no simple name for a unit of area, nor for a unit of length, nor of energy, nor for any of the quantities we are compelled to think continuously about. This makes argument or explanation on any general subject long and clumsy. To meet this need the author has compiled a list of proposed names which have been formed by adding "on" to the root of the common idea name; for example, "linon" is proposed as the unit of length; "cubon," the unit of volume; "tenson," the unit of intensity of tension; "ergon," the rate of doing work, etc. These terms, it is to be understood, are general and have no reference to any particular system of units. For example, "ergon" differs from "erg," in that the erg is a perfectly definite and particular quantity of energy with a definite numerical energy, while an "ergon" may be more or less energy according to the particular system of measures employed. It, however, always has the numerical value "one," which means simply a unit of work or unit of energy without any qualification as to any particular system. By a few examples it is shown how the use of such terms simplifies expressions, making them brief and definite. The whole of scientific theory is built up on a general basis without reference to special measures, and the use of such a system of names would very greatly simplify an enormous mass of wordy teaching and investigation and make it more concise and less ambiguous. Such language has also helped toward the development of truer conceptions of physical quantities.—*Abstracted from the Electrical Engineer (London), March 13.*

### A Mechanical Effect Accompanying Magnetization.

In the electron theory of matter the magnetic properties of bodies arise from the motion of the constituent electrons of their atoms. All bodies are divided according to their magnetic qualities into three classes: diamagnetic, paramagnetic and ferromagnetic. Bodies belong to the diamagnetic class if their atoms possess no resultant magnetic axes; they would also belong to this class if they possessed a resultant magnetic axis, but this axis had no tendency to set itself in a definite direction in an external magnetic field. Paramagnetic and ferromagnetic substances appear to result when the constituent atoms possess a resultant magnetic axis, and also set themselves in a definite direction under the influence of an external magnetic field. The difference between the two classes appears to depend on the relative magnitude of the atomic magnetic moment and the forces called into play by the displacement of the atoms. When the restoring forces of non-magnetic type, due to a small displacement, give rise to a couple which is great compared with that exerted by the external field on the equivalent atomic magnet, the magnetic fields at our disposal will produce but small rotations of the atoms, and these small rotations will be proportional to the external magnetic field. For small rotations the resultant intensity of magnetization will be proportional to the rotation, and thus the intensity of magnetization will always be proportional to the magnetizing field. The body will thus be paramagnetic. Ferromagnetic substances are those for which the restoring couples are not great compared with those of magnetic type. In this case we are able to apply external fields great enough to bring all the atomic magnets into line with the applied field. The body will then possess its maximum or "saturation" value of intensity of magnetization. On this view it will be seen that the distinction between paramagnetic and ferromagnetic substances is one of degree only. It depends only on the magnitude of the restoring forces of non-magnetic type compared with the displacing forces of magnetic type. It might be possible for a substance, which is in general paramagnetic, to become ferromagnetic by combining it with some substance which increases the freedom of motion of its atoms. This may be the explanation of the Heusler alloys and, conversely, it would explain the behavior of some of the alloys of iron. On this view the resultant magnetic fields of magnetic substances arise from the motion of their constituent electrons in closed orbits. The effect of this motion is here discussed by O. W. Richardson, who deduces an expression for the moment of momentum of the rotating electrons. The most usual form of the electron theory of matter assumes that the negative electrons alone are in motion, and most of the experimental facts seem to be in favor of this conclusion. Assuming this to be the case, his expression for the moment of momentum is much simplified, and it is found that the ratio between this moment per unit volume and the intensity of magnetization is the same for all substances and is equal to twice the inverse of the specific charge of the negative electrons. If such a moment of momentum exist, it might be possible to detect it experimentally, for, considering a long, thin, cylindrical bar of iron, when the bar is not magnetized, its constituent electrons will not possess a resultant moment of momentum about any axis, as on the average one direction is as possible as another. But if a vertical magnetic field be suddenly applied, the movable orbits will be set so as to leave a balance in favor of the plane perpendicular to the direction of the field. There will thus be created a moment of momentum about the axis of suspension. But since the total moment of momentum of any self-contained system is invariable, this moment of momentum acquired by the revolving electrons must be balanced by an equal reaction elsewhere. This reaction may be sought for in one of two places. The most reasonable is to suppose that it is effective on the rest of the atom, the part which is not revolving in an orbit. In this case it would be made evident by the twisting of the suspended system as a whole, but this twist would be temporary only, owing to the restoring effect of the torsional couple arising from the suspension. The other possibility is that there is a reaction of electromagnetic origin on the magnetizing system. Theoretical calculations show that the latter effect would be too small. The author has conducted some experiments to determine whether any twisting effect can be set up, but so far has not been successful, as it is difficult to eliminate all disturbing effects.—*Abstracted from the Physical Review (Lancaster), March.*

# INDUSTRIAL SECTION

**ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS**

## The Kelman "Short-Circuit"-Breaker.

An interesting installation of what is believed to be the first 75,000-volt automatic oil circuit-breaker operating without the use of series transformers has been placed in service at the substation at Fernando, Cal., of the Edison Electric Company.

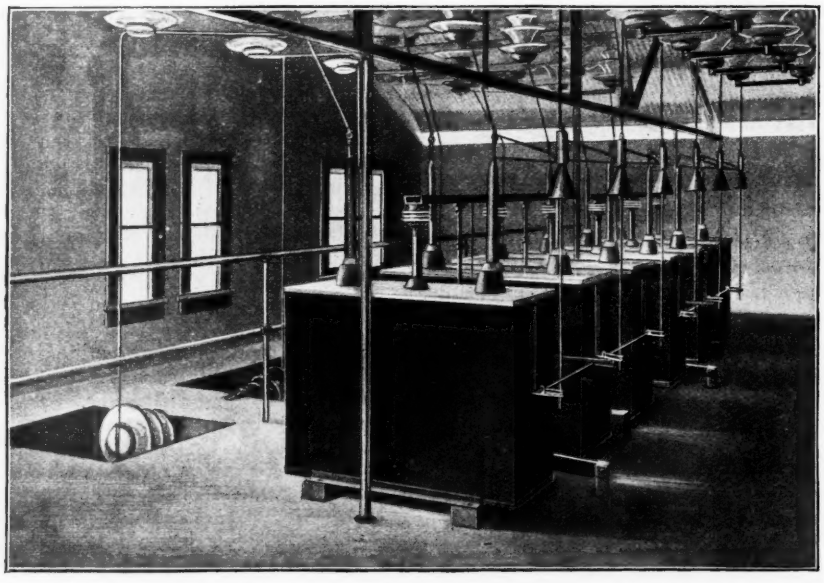
The accompanying illustration shows this installation, and the diagram herewith shows the construction of the mechanism. The movable contacts are of the knife-blade type, being part of a simple pantograph, the lower part of which is pivoted to the metal cap of the central insulator, and the upper part to the end of a wooden rod which is attached to the special porcelain insulator attached to the channel-iron cross-bar. A vertical movement of the cross-bar imparts a horizontal movement to the ends of the blades as they leave the contacts, these ends being brought together in the centre of the tank in the open position of the switch, as is shown by the dotted lines. The cross-bar is carried on two guide rods placed in cast-iron frames between the tanks, the vertical movement being given to the cross-bar by means of a rocker shaft beneath the central tank, having two arms, which are connected to the lower ends of the guide rods by means of links. The counterweight is also mounted on the rocker shaft.

The tanks are of iron, and the covers of marble made in two pieces, either one or both of these pieces being removable for purposes of inspection without disturbing any other part.

The circuit-breakers shown in the illustration herewith are arranged for hand-closing, the handle being carried loosely on the rocker shaft and connected to the closing mechanism by means of a short lever and a dog, the dog being released by the reaction of the tripping mechanism in the event of an overload or short-circuit. The tripping mechanism is set in motion by any one or any two of the trip coils independently, or by all three acting together and is automatically reset each time the breaker opens.

The trip coils consist of a few turns of small diameter, and are placed directly in the line, being suspended from the insulators of the disconnecting switches and supported by the connection to the switch terminals. The insulation of the movable core has a long creepage surface, approximately sixty inches, and a dielectric strength of at least three times the line voltage.

These circuit-breakers have been installed in all the substations of the Edison Electric Company's 75,000-volt transmission line from Kern River to Los Angeles,



CIRCUIT-BREAKERS INSTALLED IN SUBSTATION AT FERNANDO, CAL., OF THE EDISON ELECTRIC COMPANY OF LOS ANGELES.

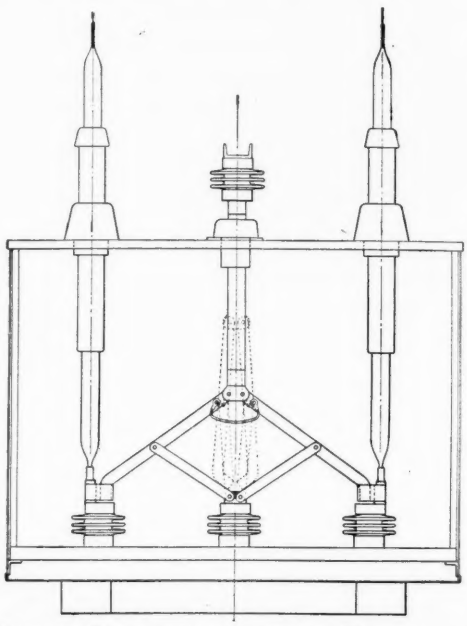


DIAGRAM SHOWING ARRANGEMENT OF KELMAN "SHORT-CIRCUIT"-BREAKER.

Cal., and during a period of several months they have operated automatically a number of times with perfect success. They are manufactured by J. N. Kelman, 1000 North Main street, Los Angeles, Cal.

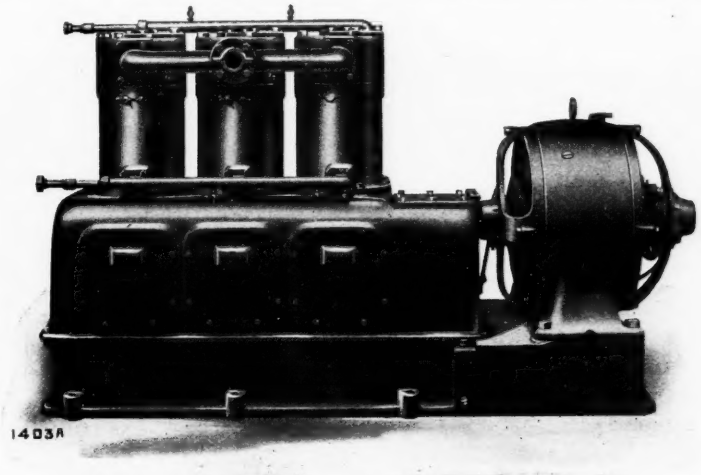
## The National Type "3VS" Air-Compressors.

The National Brake and Electric Company, Milwaukee, Wis., has placed on the market a self-contained electrically operated air-compressor of medium capacity and occupying a minimum of floor space. The machines are of rugged construction throughout and eliminate, as far as possible, all chance for injury to any of the parts.

These compressors are of the single-stage type with three vertical cylinders. All working parts are entirely enclosed. The compressors are designed for continuous service at ninety pounds pressure, but can be furnished for pressures up to 150 pounds at slightly reduced capacity rating.

The main frame consists of two pieces, the upper and lower halves. The lower half supports bearings for the crank

shaft, and also acts as a storage chamber for storing the oil used in lubricating the working parts of the machine. The upper half is heavily ribbed so as to give a maximum of strength to support the




National Brake and Electric Company Type "3VS" Motor-Driven Air-Compressor.

cylinders, and is provided with doors on each side giving access to the crank chamber, crank shaft, connecting rods, etc. No separate sub-base is required, as the driving motor is mounted on an extension of the lower half of the compressor frame.

The gear and pinion, which are mounted inside the crank case, are of the

Direct-Current Starter.

herring-bone type, the gear being of open-hearth steel and the pinion of special tool steel.

The compressor is provided with trunk pistons, and each piston has a self-adjusting metal packing ring. The discharge valves are of the tubular type, turned from solid stock.

The lubrication of the bearings and all other working parts is entirely automatic. The gear is partly submerged in oil, and the piston and wrist pins are oiled automatically. These compressors may be operated with either direct-current or alternating-current motors. The direct-current motors are of the company's standard CS type, and are heavily compounded. The armature shaft is of special construction and carries the pinion. On its extreme end it has an outboard bearing which is mounted within the crank chamber assuring steadiness of the pinion.

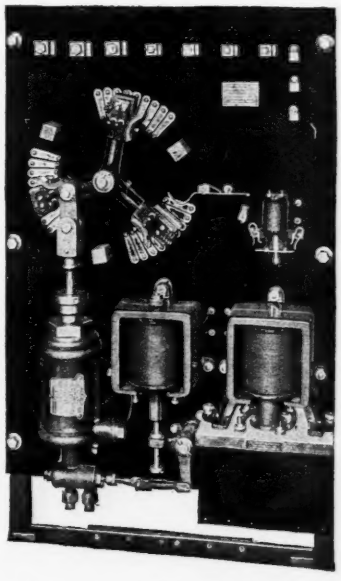
The alternating-current or induction motors used with these compressors are well adapted for air-compressor work. They are of the solid-ring type and designed for operation on two or three-phase circuits of either twenty-five or sixty cycles. The two-phase machines are for operation on 200 and 400-volt circuits, and the three-phase motors for operation on 200, 400 and 550-volt circuits.

For starting service automatic starters, which consist of an air governor and an automatic rheostat, are furnished. These starters automatically control the operation of the compressors, keeping the air-compressor within a desired range.

The direct-current starters consist essentially of a magnet in series with a lamp resistance, an electrically equipped air-gauge or pressure regulator, a main switch, and an automatic resistance, all mounted on a cast-iron panel. The electric equipment of the air-gauge consists of a three-point switch, which closes the circuit through the magnet at the time of starting the motor and short-circuits the magnet while leaving the lamp resistance in series at the time of stopping the motor. The energizing of the magnet closes the main switch in the motor circuit and tends to cut out the automatic resistance which restricts the amount of current passing to the motor at the time of starting. This resistance consists of a tube of carbon discs arranged with a varying degree of contact with one another. The lever arm is actuated by the same solenoid that operates the main switch, and a dashpot is employed to retard its movement. The resistance is finally short-circuited by a laminated brush contact and a carbon-copper break. The main switch has three breaks all in parallel.

The alternating-current starters consist of a slate panel on which is mounted a double-pole, oil-immersed line switch, a resistance in circuit with the secondary windings of the motor, a commutator for cutting this resistance out of circuit, a device for operating the rheostat lever, and a pressure regulator or governor which is adjusted for the desired range of pressures. The motor is started by closing the main-line switch, after which the starter operates and automatically cuts the starting resistance out of the armature circuit, thus gradually bringing the motor to a stop. When the air pressure reaches a desired maximum the regulator operates, and the motor is stopped.

The device for operating the rheostat lever consists of a cylinder and a piston which operates both ways under pressure, and is controlled by a solenoid. When the main-line switch is closed, this valve solenoid is energized, lifting the valve and



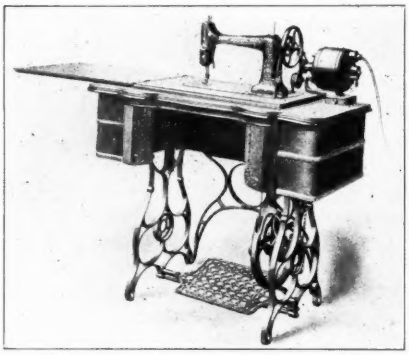
Alternating-Current Starter.

admitting water or air under pressure to the cylinder. This pressure moves the piston forward, cutting the starting resistance out of circuit. When the regulator has been acted upon by the air pressure and the motor stopped, this valve solenoid is de-energized and the valve shifted to the reverse position, thus returning the rheostat lever to the starting position.

## A Universal Family Sewing-Machine Motor.

All sewing machines may look alike, but the fact that they are not alike is brought home very frequently to the central station man when it comes to supplying the demand for sewing-machine motors.

This application of the motor is so highly appreciated in the household and there

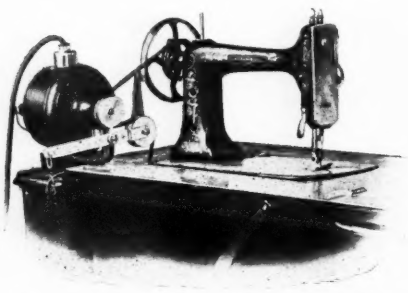


Sewing Machine with Direct-Current Motor.

are so many sewing machines of various makes in use that the demand for sewing-machine motors, though already extensive, is just beginning to make itself felt. It offers a decidedly attractive means of increasing the business of the central station.

As the demand increases the central station man or dealer finds himself in need of a motor that can be attached to one make of machine as well as to another. Otherwise a nice and profitable business is bound to become troublesome to handle and require the carrying of a large stock of motors and consequently a considerable investment.

To meet the demand for a motor that will reduce the selling effort upon the part of the dealer to the minimum and enable him to get prompt returns, the Westinghouse Electric and Manufacturing Company, of Pittsburg, has placed upon the



Drop-Head Sewing Machine with Alternating-Current Motor.

market a motor with all the necessary attachments for fitting any one of the standard types of sewing machines.

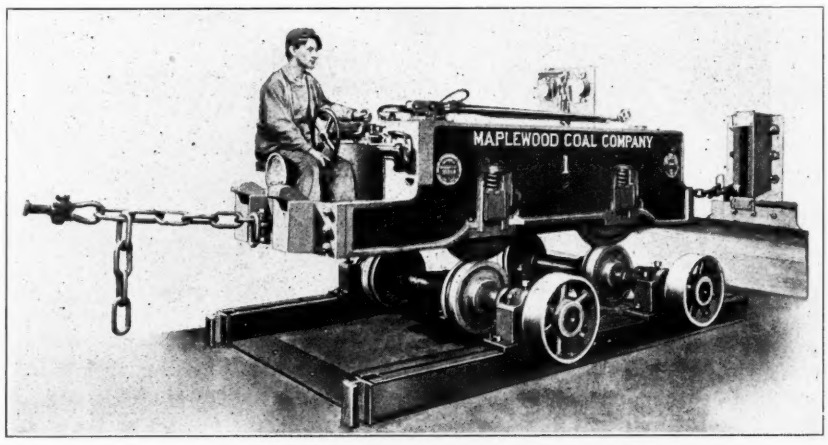
This motor is equally satisfactory on drop-head and stationary-head machines, and may be fitted to new or old machines. Full instructions for mounting and operating the motor are supplied with each outfit.

The motor is mounted on the top of the table and runs at a constant speed. The speed of the needle is regulated by increasing or decreasing the belt tension. A special brake and belt-tightener arm is attached by chain to the pedal, which should be disconnected from the large balance wheel. Pressure on the pedal releases the brake, tightens the belt and starts the machine. Perfect regulation of the speed is obtained after a few minutes' practice. In fact, the needle may be stopped with greater promptness than when running from the pedal, and the usual control over the speed is readily learned.

The entire outfit presents a neat appearance, being well finished in black japan with nickel trimmings. The motor and its attachments are especially well made and will require a minimum of care and of attention in operation. These machines are made for 100-110-volt, alternating-current, sixty-cycle, and for 100-110-direct-current circuits.

## Electric-Locomotive-Testing Plant in the Baldwin Locomotive Works.

In order to determine the actual performance of Baldwin-Westinghouse mine and industrial locomotives under service conditions before they leave the works the Baldwin Locomotive Works has erected a testing plant similar to the locomotive-




Electric Locomotive on Testing Machine, Baldwin Locomotive Works.

testing plant that was used at the St. Louis Exposition.

This plant, as shown in the accompanying illustration, consists of a pair of adjustable rolls upon which are placed wheels that may be moved to accommodate locomotives built for any gauge. Provision for varying the wheel base is made by movement of the rolls toward or away from each other.

The locomotive to be tested is anchored in position by chains attached to the ends. Suitable prony brakes are used to measure the power developed by the motors, and a switchboard provided with the necessary electrical instruments enables a complete record to be made of the performance of every locomotive.

Although a thorough test of the electrical equipment is always made before it leaves the Westinghouse works at East Pittsburg, this test of the assembled locomotive is found to be of great advantage, in that it insures the ability of the locomotive to operate continuously under service conditions.

## A New Locking Socket.

A special lamp socket has recently been placed on the market by the General Electric Company, Schenectady, N. Y., which

New General Electric Locking Socket.

should prove a boon to hotel managers, factory owners, managers of amusement resorts and others who suffer lamp losses by petty thievery.

In the old style of locking socket the lamp was held rigid in the socket, and at-

tempts to remove it generally resulted in breaking the globe. In the new style the screw shell turns freely and the lamp can not be removed until the shell is locked with the key.

The socket is shown in the accompanying illustration, and it should be noted that the addition of the locking feature has been made without detracting in any way from the neat appearance of the standard socket.

This locking socket should also appeal to those who had contemplated using the higher-priced tantalum and tungsten lamps, but who had deferred doing so on account of the extra inducements offered to the sneak thief.

## Insulators for Extremely High-Voltage Lines.

The accompanying illustrations show some new developments in insulators for high-voltage lines which have been brought out by Fred M. Locke. The frame-type insulator shown in Fig 1 has been designed for lines requiring 150,000 volts line pressure. This insulator will stand a spray test of 280,000 volts,

FIG. 1.—FRAME-TYPE INSULATOR FOR EXTREMELY HIGH VOLTAGES.

leaving a large factor of safety. It will carry a mechanical load of 20,000 pounds, and can be constructed to carry as much more as desired by increasing the I-beams and side rods and the bearing surface of the porcelain. The frames are interlocked like a chain, and the line can not come down. All the porcelain parts are under compression and are designed to have a surface large enough to carry the required mechanical load with a large factor of safety. Under an electrical test this insulator does not show the usual static stresses, and is extremely quiet up to the arcing point which takes place between the frames. In case of an arc from lightning, this will take place between the frames and not injure the insulator. These insulators are furnished in any size for line voltages from 70,000 volts

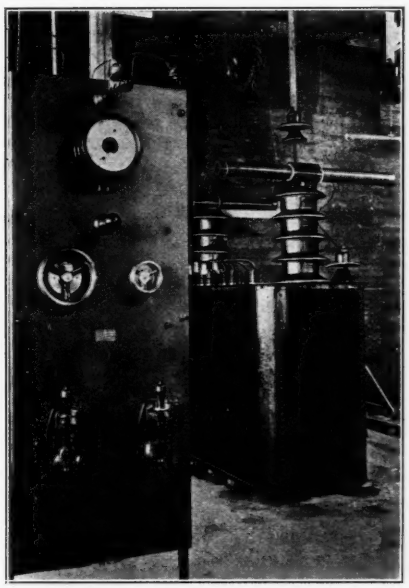


FIG. 2.—450,000-VOLT, 150-KILOWATT TESTING TRANSFORMER.

up to 300,000 volts, with a factor of safety of two under a spray test and any mechanical load desired. The in-

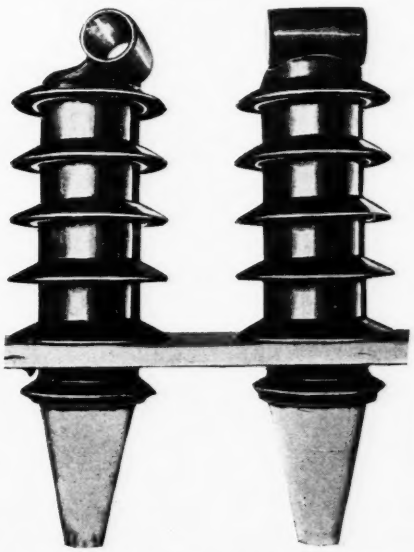


FIG. 3.—PORCELAIN BUSHINGS FOR 450,000-VOLT TRANSFORMER.

sulator is designed for the hanging type, but can be supported at either end, and may be used horizontally or perpendicularly. The insulator is manufactured exclusively by the Lima Insulator Company, Lima, N. Y., under Mr. Locke's rights to patent which are now pending.

Fig. 2 illustrates Mr. Locke's 450,000-volt, 150-kilowatt transformer, which is used to test these insulators. This is installed at the Lima Insulator Company's plant, and was made by the Central Laboratory Supply Company, of Lafayette, Ind.

Fig. 3 shows the porcelain bushings manufactured by the Lima Insulator Company for the 450,000-volt, 150-kilowatt transformer. These are insulating successfully the lead wires. The bushings are oil-filled, and the holes through the top caps support the choke-coils at each terminal. These bushings weigh about 200 pounds each.

## The Queen "Acme" Arc Lamp.

The accompanying illustration shows a new form of lamp which Queen & Company, Philadelphia, Pa., have placed on the market. The Queen "Acme" arc lamp is the result of careful research and exhaustive experiments in the production of an arc lamp for maximum illumination

QUEEN "ACME" ARC LAMP WITH FLUTED REFLECTOR.

with minimum power consumed. It is a small lamp, fifteen inches over all, of elegant design and workmanship, and is strongly built to suit the most severe conditions of service.

The lamp is equipped with alabaster globe and reflector, and gives 800 candle-power at 2.5 amperes. With clear globe and reflector the lamp gives 1,250 candle-power at 2.75 amperes. With opal reflector the lamp gives 1,000 candle-power at 2.75 amperes.

The even operation of the lamp makes it pleasant to the eye and admits of a great deal of work which is impossible under flickering arc lamps.

The color of the light very closely resembles daylight, and makes it valuable for the matching of colors and in other industrial work.

The standard lamp is made in several finishes—black enamel, oxidized copper, nickel plate and Persian antique.

# Current Electrical News

## DOMESTIC AND EXPORT.

FIFTY-MILLION-DOLLAR BOND ISSUE AUTHORIZED BY INTERBOROUGH STOCKHOLDERS—An issue of $50,000,000 of first mortgage bonds was authorized by the stockholders of the Interborough Rapid Transit Company at their special meeting on March 28. The issue is in accordance with the plan announced some time ago and which was submitted to the Public Service Commission for approval. Minority stockholders at the meeting opposed the creation of a mortgage to cover the proposed bond issue, but the management had much more than the amount of stock needed to carry the plan through, as the great bulk of the company's stock is owned by the Interborough-Metropolitan Company.

NEW TRACTION COMPANY—Announcement is made in local traction circles of the organization of a new company, to be known as the Cleveland, Orrville, Coshocton, Zanesville & Elyria Traction Company, which will take over the properties of the Cleveland, Brooklyn & Elyria Company, which was organized to build a traction line from Cleveland to Elyria, Ohio. It is announced that the new company will have $4,800,000 stock and an equal amount of thirty-year five per cent bonds. It is said that it has obtained right of way to Zanesville and will connect there with the Ohio Electric Railway, and through cars will be operated to Columbus. It is stated that the bonds have been placed in the East and the road will be completed to Elyria this year, and in 1909 to Zanesville. The new interests will take over the properties at a meeting May 7.

E. H. HARRIMAN BUYS OUT HENRY E. HUNTINGTON'S TROLLEY INTERESTS IN CALIFORNIA—Henry E. Huntington's entire interests in the steam and electric railways of Los Angeles, Cal., and the state of California, have been taken over by E. H. Harriman, who will dictate the future of the Pacific Electric, the Los Angeles Pacific, the Los Angeles Railway Company, the Los Angeles Interurban Railway Company, and the Los Angeles & Redondo Railway Company, one of the largest and most complete trolley systems in the world. Mr. Harriman also controls the Pacific Light and Power Company. The transfer involves something like $50,000,000. It means that the Southern Pacific will be in control of the trolley lines of southern California in addition to a majority of the railroad lines. H. E. Huntington denies the report from Los Angeles that he has transferred his large interests in electric railways of California to the Southern Pacific, or to Mr. Harriman.

WATER POWER OF MENOMINEE RIVER TO BE DEVELOPED—The Menominee Light and Traction Company has purchased the rights of former Mayor William Holmes and will commence to develop the extensive water power of the Menominee River by building a $400,000 power plant at Chappee Rapids, four miles from Menominee, Mich., and transmit electric current to Menominee and Marinette, Wis., for light and power purposes. Employment will be given to hundreds of men during the coming summer. The interurban street-car line between Menominee and Escanaba, which was surveyed several years ago, will be built as soon as the right of way can be secured. Within fifty miles of this city the Menominee River is capable of developing 60,000 horse-power, all of which can be utilized and transmitted to Menominee and Marinette. Chappee Rapids will develop 10,000 horse-power which will be utilized by Menominee and Marinette manufacturers.

MUNICIPAL LIGHTING PROPOSED FOR OMAHA—The city council of Omaha, Neb., will be asked by the Omaha Real Estate Exchange to submit to the voters at a special election in May the question of issuing $5,000,000 bonds to build and equip a municipal power and lighting plant. This was decided at a special meeting of the exchange. President Graham, Secretary Tukey, D. C. Patterson, C. F. Harrison, F. D. Wead, J. F. Flack and B. R. Hastings were chosen a committee to consider the best means of placing the matter before the council and the people. At a meeting reports of expert engineers were read to show that a plant can be built and equipped for less than $5,000,000. These reports give estimates on three different propositions: The Loup River project, the Columbus project and the Seymour Park project, all of which are declared feasible. The Loup River scheme contemplates a canal twenty-five miles long to generate power at Columbus, from which place the current would be transmitted to Omaha. The Fremont scheme proposes a canal leading water from the Platte at Linwood and extending about twenty-seven miles to Fremont, where power would be generated. The Seymour Park project would embrace a canal forty-four miles long, from the Platte River, near Fremont, ending in a power plant at Seymour Park, near South Omaha.

## NEW PUBLICATIONS.

"HUNTING THE MAGNETIC POLE"—Dr. L. A. Bauer, director of the department of research and terrestrial magnetism of the Carnegie Institute, Washington, D. C., has reprinted his article entitled "Hunting the Magnetic Pole," which appeared in the *Van Norden Magazine*, November, 1907. This is a historical sketch of the work of Captain Roal Amundsen, who, during his recent trip through the Northwest Passage, obtained for the first time an accurate location of the north magnetic pole.

FOREST PRESERVATION—The Forest Service of the United States Department of Agriculture has issued a circular by R. S. Kellogg, entitled "The Drain Upon the Forests," which discusses the rate of consumption of wood for various purposes and the annual rate of growth. From the figures obtainable this shows that we have only from thirteen to thirty-three years' supply, according to the estimate of the forest area. The wide divergence of these estimates emphasizes the need for more accurate data.

UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE—The United States Department of Agriculture, Forest Service, has published two interesting circulars devoted to the southern Appalachian Mountains. Circular No. 143 is entitled "The Relation of the Southern Appalachian Mountains to Inland Water Navigation," by M. O. Leighton and A. H. Horton, of the United States Geological Survey. Circular No. 144 is entitled "The Relation of the Southern Appalachian Mountains to the Development of Water Power," by M. O. Leighton, M. R. Hall and R. H. Bolster, of the United States Geological Survey.

REPORT OF EDUCATION—The report of the Committee on Education of the Syracuse (N. Y.) Chamber of Commerce has been issued. This committee consisted of Dean William Kent, A. B. Blodgett, D. E. Hawkins, J. E. Sweet and G. D. Babcock. Each member of the committee has reported upon some phase of the problem. Mr. Blodgett takes the public schools of Syracuse; Mr. Sweet the industrial school; Mr. Babcock the Syracuse Trade School for Women; Mr. Hawkins gives a dissertation upon education and democracy, and Dean Kent two articles, one dealing with recent educational literature, and the other a proposed half-time school for office boys.

KANSAS ACADEMY OF SCIENCE—The Transactions of the Kansas Academy of Science for the year 1907 has been issued. This is Part i of Volume xxi, and contains a report of the fortieth annual meeting held last November, at which a number of papers of interest were read and discussed. These are on various subjects and include the address of President James A. Yates entitled "The Value of the Work of the Scientist to Humanity," seven papers on chemical subjects, four on geological subjects and twelve on biological subjects. There are also a number of miscellaneous papers, one of these being entitled "Harmonic Forms," by Bernard B. Smyth, which is a very complete analysis of the magic square of sixteen numerals. Another by W. F. Hoyt discusses some recent scientific fallacies and frauds.

## OBITUARY NOTES.

MR. JOHN A. BRILL, the well-known street-car manufacturer of Philadelphia, Pa., died on Thursday of last week at his home in that city. Mr. Brill had been in poor health for some years past, and his demise was not unexpected. He was very widely known in electric railway circles.

MR. WILLIAM A. KREIDLER, founder and principal proprietor of the *Western Electrician*, died of apoplexy in Augusta, Ga., on March 26. Mr. Kreidler was born in South Dansville, N. Y., August 20, 1858. He was the son of Mr. and Mrs. Peter Kreidler. He attended the University of Rochester, class of 1884, and was a member of the D. K. E. Fraternity, but before graduation removed to Chicago and entered the employ of the Western Electric Company. Early in life he was interested in journalistic pursuits, and while acting as secretary to Mr. Barton, of the Western Electric Company, became the first Chicago correspondent of the ELECTRICAL REVIEW. He later joined the staff of the *Electrical World*, and in 1887 established the *Western Electrician*. His life thereafter was devoted to the direction of this paper, which, under his guidance, became one of the leading technical journals of the country. Mr. Kreidler also engaged in outside non-electrical business ventures, with a large measure of success. He was one of the organizers of the old Chicago Electric Club, and was its secretary for several years. Mr. Kreidler's city home for many years was at the Belden, Chicago, Ill., but he spent much of his time at his country house in Lake Bluff, Ill. He was a member of the Union League Club, Exmoor Country Club and the Lake Bluff Country Club, as well as the American Institute of Electrical Engineers, the National Geographic Society and the Chicago Academy of Sciences. He was a pewholder in the Church of our Saviour. Mr. Kreidler was a man of fine business ability and possessed marked literary taste, owning a collection of fine books. He possessed some skill as an inventor, one or more patents having been taken out in his name. He will be remembered as a kind-hearted man of generous impulses, and his leath is sincerely regretted by a large number of friends. In 1893 Mr. Kreidler married Miss Netta Ophelia Preston, who survives him. The other immediate members of his family are his mother, sister and two brothers, living in Olean, N. Y. The funeral was held on Monday, March 30, from the family residence in Lake Bluff, the interment being made at Lake Forest, Ill.

## ELECTRIC RAILWAYS.

LINCOLN, NEB.—The Illinois Traction System has completed its line between Lincoln and Mackinaw.

REDLANDS, CAL.—At a meeting of the San Bernardino Valley Traction Company, H. E. Huntington was elected president to succeed A. C. Denman, Jr., of Redlands, who will continue as general manager.

WHEELING, W. VA.—The Wheeling Traction Company has begun to plan the work of extending the Pan-Handle Traction Company's lines into the city, under the terms of the new franchise granted several months ago.

RENO, NEV.—The Virginia & Truckee Railroad Company has plans under way for electrifying its line from Reno to Carson City the coming summer. It is probable that construction work will be started within two or three months.

RIVERSIDE, CAL.—Construction work on the Riverside-Colton trolley line is to be started at once. Under the terms of the contract with the Riverside Business Men's Association, which assisted in securing rights of way, the line must be in operation within fifteen months.

SANTA ANA, CAL.—It is announced that a road to be known as the Santa Ana-Tustin-Huntington Beach Railroad will be incorporated to connect Santa Ana and Huntington Beach. The estimated cost is between $100,000 and $110,000, and local capital will be available.

GREELEY, COL.—Work on the survey of the line of the Greeley & Northern Utility Company, in the city limits, has been begun. F. O. Oler, of St. Paul, the financial agent of the company, stated that private right of way through the city had been secured and that work on the line would be pushed.

BIRMINGHAM, ALA.—At a meeting of the railway committee of the city council the Birmingham Railway, Light and Power Company was granted an extension of one year on sixty-five blocks of the city's streets, the franchise for the use of which had been given for a consideration of $10,000.

MONONGAHELA, PA.—The city council has granted the Monongahela & Carroll Street Railway Company a franchise over Park avenue to the city limits, work to be started within six months. George Hosack, of Pittsburg, is president of the company, and it is proposed to build a line from here to Washington.

TOPEKA, KAN.—The Marlam Construction Company, of Kansas City, Mo., has secured a $500,000 charter from the secretary of state. The purpose of the company is to build the Kansas City & Kansas Southwestern Electric Railroad line between Kansas City and Topeka and Lawrence and Independence. The same parties that secured the recent charter for the line are interested in the construction company. They claim work will begin immediately.

WILMINGTON, DEL.—The Eastern Railway Construction Company has organized by electing J. Frank Ball president, and Gerald J. O'Connell, of West Chester, Pa., secretary and treasurer. This is the company organized recently to build the new railway from this city to West Chester. It is proposed to start work as soon as the weather will permit.

LAKEWOOD, N. J.—Lakewood capitalists have taken up the Lakewood-Point Pleasant trolley. The capital is to be $120,000, common stock, and a bond issue of $100,000 thirty-year five per cent first mortgage bonds is provided for. With $50,000 already spent for right of way and construction of the road, the promoters say that the line can be built for $100,000. It is proposed to have the road completed and in operation by July first of this year.

ANNAPOLIS, MD.—Delegate Peach, of the Prince George County delegation, has introduced in the house a bill incorporating the Washington, Patuxent & Drum Point Railroad. The bill names as incorporators: Ira J. Baker and Charles C. Mayer, of Washington; C. A. M. Wells, Joseph R. Owens, Rexford M. Smith, Wallace A. Bartlett and Charles A. Wells, and fixes the capital stock at $250,000, with power to increase. It provides for the construction of either a steam or electric railroad from a point on the Chesapeake Beach Railway through Calvert, Prince George and Arundel counties to Solomon's Island, at the mouth of the Patuxent River.

HYATTSVILLE, MD.—Senator William B. Clagett, of Prince George County, has introduced a bill in the Maryland legislature incorporating the Washington & Maryland Electric Railway Company, which proposes to operate a trolley line from Washington to Ritchie Station. The company is to have an authorized capital of $25,000, which may be increased to $200,000. The bill names as incorporators: Horace Crosier, Samuel E. Cox, T. Van Clagett, George S. Dove, F. Snowden Hill, George Zurhorst, Albert Carry, Alfred G. Shaw and Ernest Gerstenberg. At Ritchie Station the new road is to connect with the Chesapeake Beach Railway.

FREDERICK, MD.—Arrangements are being made to build a trolley line from Wolfsville, this county, to connect with the line from Myersville to Hagerstown. A survey, showing a low grade, has been made, and, with one or two exceptions, the owners of land along the route have agreed to donate the rights of way. It is stated that officials of the Hagerstown & Myersville Railway Company have assured the promoters of the project that if they can secure half the amount needed to build the line in stock subscriptions from persons living along the route the railway company will furnish the balance of the money and build the road, which will be operated as a branch of its line to Myersville.

NIAGARA FALLS, ONTARIO—The promoters of the Dunnville, Wellandport & Beamsville electric railway claim that they now have a definite proposition to submit to the municipalities through which their proposed railroad is to run and propose to go on with the work of construction this coming summer. Arrangements have been made with the banking firm of William W. Umbenhauer, of Philadelphia, to finance the proposition. The provisional directors are: James A. Ross, Wellandport, president; F. R. Lalor, M. P., vice-president; M. Smith, Thomas Marshall, B. L. Edgecombe, M. L. Perry, F. J. Ramsey and E. E. Anderson. The railroad is designed to start at Dunnville and run to Wellandport, thence to St. Anns and Beamsville. The charter expires next May and so far no steps have been taken to renew it.

## ELECTRIC LIGHTING.

SLOCOMB, ALA.—The city council has advertised for bids for the installation of an electric light plant.

MONTPELIER, OHIO—The proposition to issue bonds of the village for $30,000 for the rebuilding of the municipal lighting and water plant was carried by a vote of 256 to thirty-two.

CLEVELAND, OHIO—The city council has appropriated $35,000 to buy machinery for the municipal electric light plant in South Brooklyn. The additions to the plant will triple its capacity.

SPENCER, IND.—The town board of Spencer has granted a franchise to the Spencer Light and Water Company, a company in which the town holds $5,000 of preferred stock. The franchise is to run for twenty-five years.

McCOOK, NEB.—The city of Orleans, Neb., has granted a franchise to Dana O. Hewitt, of McCook, for electric light and power for a term of twenty years. The construction of the plant will begin at once. A. R. Scott, of McCook, has been retained as consulting engineer.

BUENA VISTA, COL.—The Buena Vista Smelting and Refining Company has been given the contract for street lighting. The company will expend more than $5,000 in improvements on its Arkansas River dam, to be twenty-eight feet high and thirty feet wide at the bottom.

KEWAUNEE, WIS.—Despite opinions that the proceedings on the special election at Kewaunee to install an electric light plant were legal, the city of Kewaunee has decided to hold another special election May 19 on the question of issuing $20,000 bonds to install a municipal light plant.

LOUISVILLE, KY.—R. E. Hughes, president of the Kentucky Electric Company, informs us that the company has closed contracts for practically all the apparatus it will need for the plant it is constructing, but that it is still in the market for cable, meters, transformers and motors.

PARIS, ILL.—Half of the stock is said to have been subscribed for the incorporation here of a citizens' electric light and power company. It is proposed to incorporate with a capital stock of $40,000. Several of the prime movers in the enterprise are members of the Paris Traction Company.

COLUMBUS, OHIO—The stockholders of the Columbus Edison Company have voted to increase the capital stock from $1,000,000 to $1,500,000. There is now an equal amount of common and preferred stock, and it is believed that the dividends of five and six per cent respectively will be maintained.

LISBON FALLS, ME.—The Lisbon Falls Gas and Electric Light men be authorized to enter into a contract with the Lisbon Falls Gas and Electric Light Company to light the streets of the village for a term of five years. It was voted to install 100 lights this year. The streets have always been lighted by kerosene.

KAYSVILLE, UTAH—B. E. Slusser has been granted an electric lighting franchise for a term of fifty years. For the present Mr. Slusser proposes to get his current from the Utah Light and Railway Company. Later, it is believed, he will generate enough electricity to light Farmington, Kaysville and Layton.

LITTLE ROCK, ARK.—The annual report of City Electrician John W. Bleidt shows that the cost to the city for its street lights was for the past year $39.04 each. During the year the lamps burned 2,858 hours. Mr. Bleidt recommends to the council that improvements be made to provide for the installation of 100 additional lamps.

TAYLOR, TEX.—The Taylor electric light plant, owned by the Williams Brothers and associates of this city has changed ownership, the works and franchise passing to the possession of a new company recently formed here, composed of T. W. Morse, C. H. Booth, Ed. A. Robertson, Howard Bland and others. It is understood that $10,000 was the price paid.

SAN FRANCISCO, CAL.—With the completion of the Western Pacific tracks up in the Sierra to a point on the north fork of the Feather River, nineteen miles above Oroville, actual material began going rapidly forward from Marysville and Oroville for the erection of the Great Western Power Company's plant, which will be rushed to completion so that it can begin furnishing electric current by October 1.

RENO, NEV.—A certified copy of the articles of incorporation of the Eastern Nevada Power Company, with capital stock of $500,000, has been filed with the county clerk. The company is composed of Utah capitalists, who propose to establish a large reservoir for irrigation and power purposes in Lincoln County, this state. The incorporators are: E. C. Lapner, A. L. Wilkins and G. A. Peters, all of Salt Lake.

NEW HAVEN, CT.—At the annual meeting of the stockholders of the United Illuminating Company Nathan B. Fitch, who has been connected with the company for some time, was elected to the directorate to fill the vacancy caused by the death of E. G. Burnham, of Bridgeport. The full list of directors elected follows: John Alling, William J. Atwater, Alfred B. Beers, Lyman S. Catlin, James English, Herbert C. Warren, Nathan B. Fitch.

SPOKANE, WASH.—Announcement is made that another plant will be built in Montana for the purpose of generating electrical power to be used in mining and other enterprises. The location of the plant is on Deep Creek, in Broadwater County, in the Big Belt Mountains. It is proposed to use the power in the Winston and Radersburg districts, in Townsend and also in dredging operations on the Missouri. It is said a number of large contracts have been secured.

GREENVILLE, S. C.—It is announced that the Southern Power Company will extend its power transmission lines to this city, construction to begin at once and to be completed by September 1. The company will also begin shortly the extension of its transmission lines from Rocky Creek to Winnsboro. The distance from Rocky Creek is eighteen miles. The distance from Winnsboro to Columbia is thirty-six miles, which city will be the ultimate point reached. There are a large number of manufacturing enterprises in the vicinity of Winnsboro.

PITTSBURG, PA.—At the annual meeting of the stockholders of the Duquesne Light Company the report of the operations of the past year was made and the following board of directors was elected: George R. Webb, D. P. Reighard, Robert C. Hall, R. H. Binns and H. B. Beatty. Mr. Hall declined re-election as president, and George R. Webb, of Baltimore, was elected to fill the position. The new officers of the company are: George R. Webb, president; D. P. Reighard, vice-president; Robert C. Hall, treasurer, and S. P. Austin, secretary. Plans were laid before the meeting for the extension of the company's business, which has been somewhat delayed by the financial situation. The plans contemplate a large central station to be located on the water front, and the present plant in East Liberty will be utilized as a substation. It is estimated that the cost of the new system will be about $4,000,000.

## DATES AHEAD.

Iowa Electrical Association. Annual meeting, Des Moines, Iowa, April 22-23.

Iowa Street and Interurban Railway Association. Annual meeting, Des Moines, Iowa, April 22-24.

American Electrochemical Society. Next meeting, Albany, N. Y., April 30-May 2.

Nebraska Electrical Trades Association. First annual electrical show, Auditorium, Omaha, Neb., May 4-9.

Nebraska Electrical Association. First annual meeting, Omaha, Neb., May 6-7.

West Virginia Independent Telephone Association. Annual meeting, Fairmont, W. Va., May 7-9.

Southwestern Electrical and Gas Association. Annual convention, El Paso, Tex., May 7-9.

Railway Signal Association. Next meeting, New York city, May 12.

Ohio Society of Mechanical, Electrical and Steam Engineers. Next meeting, Columbus, Ohio, May 15-16.

National Electric Light Association. Annual meeting, Chicago, Ill., May 19-22.

Telephone Association of Texas and Louisiana. Annual meeting, Dallas, Tex., May 25-27.

Oklahoma Electric Light, Railway and Gas Association. Annual meeting, Guthrie, Okla., May 25-27.

American Institute of Electrical Engineers. Annual meeting, Atlantic City, N. J., June 29-July 2.

National Electrical Contractors' Association. Next meeting, Chicago, Ill., July 15.

American Society of Municipal Improvements. Annual meeting, Atlantic City, N. J., October.

## PERSONAL MENTION.

MR. ANGUS S. HIBBARD, vice-president and general manager of the Chicago Telephone Company, was a visitor to New York city last week, conferring with other prominent telephone officials.

MR. GEORGE K. HUTCHINS, who has been contract agent for the Columbus (Ga.) Power Company for two years, has accepted a similar position with the Savannah Electric Company, of Savannah, Ga.

JUDGE A. B. BEERS, of Bridgeport, Ct., has been elected vice-president of the United Illuminating Company, of New Haven, Ct., to take the place of the late E. G. Burnham. Frederick D. Adams was elected to fill the vacancy caused by the death of the secretary and treasurer of the company, Addison F. Hunie. Mr. Adams has been connected with the company since 1889.

MR. HARRY E. GLASS, who has been superintendent of the lighting system of the West Penn Electric Company in the Monongahela Valley, has been promoted to assistant general superintendent of the company. He will be located at Connellsville, Pa. R. L. Buffington, at present commercial agent of the company at Connellsville, will succeed Mr. Glass, while F. C. Eckels, of Monongahela, will have charge of the district from Donora to Elizabeth.

MR. EDWARD R. TAYLOR, of Penn Yan, N. Y., has been awarded the Elliott-Cresson medal by the Franklin Institute, of Philadelphia. This is in recognition of Mr. Taylor's work in developing an electric furnace for the production of carbon bisulphide. These furnaces have been described from time to time in the ELECTRICAL REVIEW and the latest models are probably the largest furnaces now in operation. At the time Mr. Taylor began his work, the electric furnace was a laboratory device only, and it required a great deal of courage and hard, patient endeavor to develop a commercial form of furnace. Since the first furnace was built Mr. Taylor has constructed a number of others, each of improved and enlarged size, the present model being forty-one feet high, sixteen feet in diameter. Mr. Taylor is a graduate of the Lawrence Scientific School, Harvard University, and is a member of the American Institute of Electrical Engineers, American Electrochemical Society, Society of Chemical Industry, American Geographical Society, and a fellow of the American Association for the Advancement of Science.

## ELECTRICAL SECURITIES.

Except for apparently a continuance of improvement there is not much to chronicle concerning the stock market. Prices moved up generally, but not with the activity witnessed for the last few weeks. This is quite as it should be, for nothing would be more unfortunate than an inflation and artificial valuation at this time. Some slight apprehension is now felt on account of the possible effect of lack of rain upon the winter wheat crop. With this element of fear removed there is much encouragement to be felt in all directions.

Dividends have been declared upon the following electrical securities: Manila Electric Railroad and Lighting Corporation; regular quarterly dividend of 1 per cent, payable April 1. Central & South American Telegraph Company; regular quarterly dividend of 1½ per cent, payable April 9. Mexican Telegraph Company; regular quarterly dividend of 2½ per cent, payable April 16 to stock of record March 31. Tri-City Railway and Light Company; regular quarterly dividend of 1½ per cent on the preferred stock, payable April 1. Colorado Telephone Company; regular quarterly dividend of 1¾ per cent, payable April 15. Manchester Traction, Light and Power Company; regular quarterly dividend of 2 per cent, payable April 15. Bell Telephone Company of Missouri; regular quarterly dividend of 2 per cent, payable April 1. West India Electric Company; a quarterly dividend of 1 per cent on the common stock. Mexican Telephone and Telegraph Company; regular semi-annual dividend of 2½ per cent on the preferred stock, payable May 1 to stock of record April 21. Fall River (Mass.) Electric Light Company; a quarterly dividend of 2 per cent. Memphis (Tenn.) Street Railway Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable March 31. Radio Telephone Company; regular quarterly dividend of 1 per cent, and an extra dividend of 2 per cent on the par value of all stock for which full cash payment has been made prior to April 1, 1908. Knoxville (Tenn.) Railway and Light Company; regular quarterly dividends of 1 per cent on the common and 1½ per cent on the preferred stocks, both payable March 31. Johnstown (Pa.) Passenger Railway Company; regular quarterly dividend of ¾ of 1 per cent, payable March 31. Columbus, Newark & Zanesville Electric Railway Company; quarterly dividend of 1½ per cent on the preferred stock, payable April 1. Omaha & Council Bluffs Street Railway Company; regular quarterly dividend of 1¼ per cent on the preferred stock, payable April 1. City Railway Company of Dayton, Ohio; regular quarterly dividends of 1¾ per cent on the common and 1½ per cent on the preferred stocks, payable April 1. Syracuse (N. Y.) Rapid Transit Company; regular quarterly dividend of 1½ per cent on the preferred stock, payable April 1. Cincinnati, Newport & Covington Light and Traction Company; regular quarterly dividends of ¾ of 1 per cent on the common and 1⅛ per cent on the preferred stock, payable April 15. Public Service Corporation of New Jersey; regular quarterly dividend of 1 per cent, payable March 31. Forest City Railway Company, Cleveland, Ohio; regular quarterly dividend of 1½ per cent, payable April 1.

ELECTRICAL SECURITIES FOR THE WEEK ENDED MARCH 28.

| *New York:* | *Closing.* |
|---|---|
| Allis-Chalmers common | 7¾ |
| Allis-Chalmers preferred | 18½ |
| Brooklyn Rapid Transit | 46¾ |
| Consolidated Gas | 114½ |
| General Electric | 126 |
| Interborough-Metropolitan common | 7¾ |
| Interborough-Metropolitan preferred | 20½ |
| Kings County Electric | 95 |
| Mackay Companies (Postal Telegraph and Cables) common | 57 |
| Mackay Companies (Postal Telegraph and Cables) preferred | 62¾ |
| Manhattan Elevated | 123 |
| Metropolitan Street Railway | 15½ |
| New York & New Jersey Telephone | 102 |
| Western Union | 52½ |
| Westinghouse Manufacturing Company | 52 |

The annual meeting of the stockholders of the General Electric Company will be held at 12 o'clock, May 12, in Schenectady, N. Y. Transfer books close April 11 and reopen May 13.

Directors of the New York & New Jersey Telephone Company have declared the regular quarterly dividend of 1¾ per cent, payable April 15 to stock of record April 4.

The directors of the Westinghouse Electric and Manufacturing Company have called a special stockholders' meeting to be held in East Pittsburg, April 29, at 10.30 o'clock, to vote on the question of issuing bonds or additional stock.

| *Boston:* | *Closing.* |
|---|---|
| American Telephone and Telegraph | 109 |
| Edison Electric Illuminating | 205 |
| Massachusetts Electric | 47 |
| New England Telephone | 109 |
| Western Telephone and Telegraph preferred | 62 |

Directors of the New England Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable May 15.

Directors of the Edison company of Boston have declared the regular quarterly dividend of 2½ per cent. The dividend is payable May 1 to stockholders of record April 15.

| *Philadelphia:* | *Closing.* |
|---|---|
| Electric Company of America | 9 |
| Electric Storage Battery common | 29 |
| Electric Storage Battery preferred | 29 |
| Philadelphia Electric | 7⅞ |
| Philadelphia Rapid Transit | 17¾ |
| United Gas Improvement | 80 |

The directors of the Electric Storage Battery Company have declared quarterly dividends of 1 per cent upon both the preferred and common stocks, payable April 1. This is a reduction of ¼ of 1 per cent quarterly upon each stock. Officers have been re-elected.

| *Chicago:* | *Closing.* |
|---|---|
| Chicago Telephone | 117½ |
| Commonwealth Edison | 91 |
| Metropolitan Elevated preferred | 49 |
| National Carbon common | 56½ |
| National Carbon preferred | 102½ |

Directors of the Commonwealth Edison Company have declared the regular quarterly dividend of 1¼ per cent, payable May 1. Books close April 21 and reopen May 4.

## NEW MANUFACTURING COMPANIES.

COHOES, N. Y.—The Robinson Electric Faucet Company has been incorporated in the secretary of state's office. The capital stock is $1,000. The directors are William H. Beattie, F. A. Robinson and F. W. Collins.

NEW YORK, N. Y.—The Radio Battery Company has been incorporated to manufacture and install batteries. The capital is $100,000, and the incorporators are: R. B. Respess, H. L. Robinson and J. W. Kinne, of New York city.

ROCHESTER, N. Y.—The Almstead Manufacturing Company has been incorporated with a capital of $30,000, to manufacture electric apparatus and supplies. The incorporators are: R. P. Almstead, M. J. Almstead and J. A. Almstead, of Rochester.

NEW YORK, N. Y.—The Baltimore Light and Equipment Company has been incorporated by G. E. Stickney, Rutherford, N. J., and W. I. Willis and M. Frank, of Brooklyn, to manufacture lighting appliances and fixtures. The company is capitalized at $100,000.

NEW YORK, N. Y.—The Sovereign Electric Manufacturing Company has been incorporated with a capital of $150,000 to manufacture lighting appliances and fixtures. The incorporators are: L. O. Hall, E. B. Hall, New York city; L. P. Smith, Mount Kisco, Westchester County, N. Y.

CHARLESTON, W. VA.—The Pierce Safety Appliance Manufacturing Company has been incorporated with a capital of $500,000, of which $310,000 has been subscribed and paid, to manufacture railway devices and signal systems. The incorporators are: Franklin A. Pierce, Earle A. Lenkard, Wheeling; John E. Oswald, John T. Waters, Bellaire, Ohio; William McSwain, Moundsville.

EVANSVILLE, IND.—Articles of incorporation of the Hoosier Storage Battery Company, of Evansville, have been filed. The company is formed to conduct a general electrical business. The directors are given as follows: John C. Zutt, Willis M. Copeland, A. F. Karges, John Weber, Ezra Lyon, Al Swanson, Louis A. Daus, J. Will Gleichman, Fred Bockstege, Carrie J. Jourdan and V. W. Jones.

## EDUCATIONAL NOTES.

CHARTER DAY EXERCISES, THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY—The twelfth anniversary of the granting of the charter of the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., was celebrated on the evening of Saturday, March 14. The exercises were held under the auspices of the Clarkson Engineering Assembly. The address of the evening was made by Cecil Brunswick Smith, consulting engineer, Toronto, Canada.

SUMMER-SCHOOL WORK—The Massachusetts Institute of Technology has issued a bulletin describing the summer courses which will be offered at that school during the months of June and July. These courses are open to all persons possessing the necessary qualifications for carrying on the work. They include the subjects of mathematics, mechanical drawing, mechanic arts, modern languages, chemistry, physics, civil engineering, mechanical engineering, architecture, and biology. Outlines for these courses are given in this bulletin, which, with further particulars, may be obtained by addressing Dana P. Bartlett, acting secretary, 491 Boyleston street, Boston, Mass.

## NEW INCORPORATIONS.

INDIANAPOLIS, IND.—Garrett Telephone Company, Garrett. Increase in capital stock from $15,000 to $30,000.

BOSTON, MASS.—Stone Wireless Construction Company, Boston. $100,000. President, J. T. Shaw, Boston; treasurer, E. N. Goding, Roxbury.

INDIANAPOLIS, IND.—Royal Electric Company, Milford. $20,000. L. M. Neher, Asha L. Miller, J. B. Neff, C. A. Sparklin, A. B. Miller and B. M. Neher.

INDIANAPOLIS, IND.—Ohio Telephone Company, Ohio, Hamilton County. $1,000. Directors: Gus Brooks, B. R. Smith, W. Brandon and F. F. Johnson.

ALBANY, N. Y.—Lima-Honeoye Electric Light and Railroad Company, Buffalo. Reorganization after sale electric light and railroad. $50,000. Incorporators: C. E. Georger, E. A. Georger, J. Jewett, Jr., J. O. Moore, Buffalo; E. D. Watkins, Lima.

## INDUSTRIAL ITEMS.

THE STEEL CITY ELECTRIC COMPANY, Pittsburg, Pa., is distributing new literature devoted to Fullman watertight floor outlets, National Code Standard.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has issued a new bulletin describing and illustrating fourteen Jeffrey specialties of interest to mining engineers.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has prepared, with the permission of the National Electrical Contractors' Association, a reprint of the symbols adopted by that association for distribution to the electrical trade.

THE MANHATTAN AUTO CAR COMPANY, New York city, announces that hereafter its sight-seeing cars will leave only from the Times Building, Times Square, Broadway between Forty-second and Forty-third streets, New York city.

THE BLAKE SIGNAL AND MANUFACTURING COMPANY, 246 Summer street, Boston, Mass., has published a new folder devoted to Blake insulated staples and compressed cleats. Copies of this bulletin will be furnished to those interested upon request.

THE WIRE AND TELEPHONE COMPANY, OF AMERICA, Rome, N. Y., recently issued a "Copper History" folder giving the monthly and yearly average selling prices of copper since 1883. The company will be pleased to furnish copies of this bulletin upon request.

THE F. BISSELL COMPANY, Toledo, Ohio, has ready for distribution a special list of bargains in electrical machinery and supplies. This includes alternating-current and direct-current motors, lighting and power dynamos and other miscellaneous apparatus.

THE SCHUTTE & KOERTING COMPANY, Philadelphia, Pa., has ready for distribution two bulletins, describing respectively, stop, check, stop check and emergency valves of the extra heavy pattern, and hard bronze valves of extra heavy pattern. These bulletins will be furnished upon request.

THE M. W. DUNTON COMPANY, Providence, R. I., has issued two cards of suitable size to fit a three-inch by five-inch quotation file, with complete information and prices on sleevings and "Nokorode" soldering paste. These cards are particularly handy and give a good deal of information in a very small space.

THE APPLETON ELECTRIC COMPANY, Chicago, Ill., has published catalogue No. 4, describing and illustrating its line of "Unilets." These can be furnished for rigid or flexible conduit, and made to fit any combination of pipe sizes desired. The covers are interchangeable with different types and styles of outlets.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Ct., in addition to the usual interesting sketches, describes plug cutouts with new terminal screws and the "Ideal" cord adjuster with new clamp in the April issue of "Trumbull Cheer." Copies of this bulletin will be furnished upon request.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., has issued a very interesting bulletin devoted to its No. 8 self-restoring gravity drop and 150-line unit-type magneto switchboard. There is a great deal of special information contained in this bulletin, and it is worked up so that that matter will be found of value to every one concerned with telephone equipment.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., general western agent for "Okonite" products, is delivering the first installation of arc-lighting equipment for the city of Chicago. This is one of the largest arc-lighting equipments that has been secured for some time, covering approximately 900 "G-I" series alternating-current arc lamps, sixteen fifty-light, oil-type arc-light regulators, and approximately 800 kilowatts in transformers.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., through its export department, has received a contract from the Dominion Iron and Steel Company, of Halifax, N. S., for a 500-horse-power generator, which will be used in the operation of one of the company's iron mines on Belle Island, Newfoundland. To what extent electric mining machinery has been introduced from America into foreign countries may be estimated

from the fact that in one of the mining camps at Guanajuato, Mexico, the Pinginco mines, no less than 250 Westinghouse electric motors are being operated, ranging in capacity from five horse-power to 200 horse-power.

DOSSERT & COMPANY, 242 West Forty-first street, New York city, announce, among recent orders received for the Dossert solderless connectors, third-rail clamp connectors for 1,000,000-circular-mil cable from the New York Central & Hudson River Railroad Company; cable taps for 400,000-circular-mil main to 0000 bleeder, from the Chicago City Railway Company, and cable taps for 1,000,000-circular-mil cable from the Syracuse & South Bay Electric Railway Company.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., devotes bulletin No. 5,910-3 to a description of power equipment for cement mills. In addition to some very interesting illustrations showing some of the larger tools used in the Hawthorne works of the company, there is an article describing individual-motor drive for the cement mill, and an illustrated description of the electrically operated plant of the Marquette Cement Manufacturing Company, La Salle, Ill.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has received orders for the following equipment: 300 four-motor equipments for the Chicago Railways Company; three 1,000-kilowatt, 2,300-volt, three-phase alternators for the Manchurian Railway, Korea; twenty-five GE-202, 600-volt, two-motor equipments, and forty type H oil-cooled transformers for the Sao Paulo Tramway, Light and Power Company, Sao Paulo, Brazil. A shipment of two fifty-kilowatt, cross-compound marine sets, together with switchboards and necessary instruments, has been made to Olongapo, Philippine Islands. These will be used in the United States Government drydock Dewey, which recently made the trip around Cape Horn.

# Record of Electrical Patents.

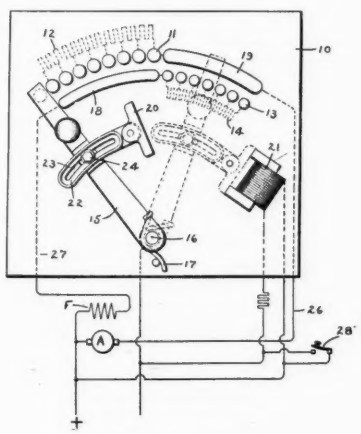
**Week of March 24.**

882,553. BLOCK-SIGNAL SYSTEM. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company. A block-signal system providing separate sources for supplying current to the track circuits of the blocks, two-coil relays, one connected to the rails of a block and the other connected to the source of current that supplies the track circuit of an adjacent block.

882,554. SIGNAL. Fred B. Corey, Schenectady, N. Y., assignor to General Electric Company. Provision for shifting the signal mechanism supplied with current from the power circuit, and a magnet supplied with current from the signal circuit for locking the shifted signal.

882,555. ELECTRIC SIGN. Samuel E. Doane, Cleveland, Ohio. An illuminated sign with a background of grouped incandescent lamps.

882,564. ELECTRIC HEATER. Edward M. Hewlett, Schenectady, N. Y., assignor to General Electric Company. A resistance unit comprised of a plurality of discs placed inside a circular casing.




882,569.—RHEOSTAT.

882,565. BRUSH-HOLDER. Fred B. Howell, Schenectady, N. Y., assignor to General Electric Company. A brush-holder with a helical junction spring threaded into a helical supporter.

882,569. RHEOSTAT. Charles D. Knight, Schenectady, N. Y., assignor to General Electric Company. A rheostat with means for locking the armature in any determined position.

882,573. STORAGE BATTERY. William L. Merrin, Fredericktown, Ohio. A storage battery with the elements containing the active material superimposed inside a corrugated sheet-iron shell.

882,581. INDUCTION-MOTOR CONTROL. Karl A. Pauly, Schenectady, N. Y., assignor to General Electric Company. An induction motor provided with two sets of connections for producing tendencies toward operation at different limiting or synchronous speeds.

882,582. PROCESS OF PRODUCING MANGANESE SILICIDE. Edgar F. Price, Niagara Falls, N. Y., assignor, by mesne assignments, to Central Trust Company of New York, trustee under first mortgage. Process for producing continuously manganese silicide by means of an electrically heated resistance conductor.

882,586. ELECTRICAL RECORDING INSTRUMENT. Lewis T. Robinson, Schenectady, N. Y., assignor to General Electric Company. One element of the recording instrument is excited by a source of constant potential and the other element by the current or energy to be measured.

882,602. CONTROLLING SWITCH. Harold E. White, Schenectady, N. Y., assignor to General Electric Company. The controlling switch is provided with individual blowout coils connected directly in series with the several contact fingers.

882,606. INDUCTION-MOTOR CONTROL. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. The primary and secondary members are adapted for connection for different pole members.

882,610. ADJUSTABLE ELECTRICAL RESISTANCE. Frederick O. Ball, Plainfield, N. J. An insulating base with provision for clamping in various lengths of looped resistance.

882,639. CONTROLLING SYSTEM FOR ELECTRIC MOTORS. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. Means for preventing a reversing switch from being moved from one position to another while the electromotive force generated by the translating device is greater than a predetermined amount.

882,649. CABLE-LAYING MACHINE. George W. Noble, Collbran, Col. A combination of a cable-laying plow and means for paying out the cable.

882,658. CONTROL SYSTEM FOR ELECTRIC MOTORS. Hermon L. Van Valkenburg, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A combination of a subdivided transformer and means for making various connections between the points of the windings and the connections in series with these leads.

882,673. LIGHTNING ARRESTER. Walter T. Goddard, Victor, N. Y., assignor, by mesne assignments, to Garton-Daniels Company, Keokuk, Iowa. A lightning arrester comprising an electromagnet, a tube of insulating material and supporting insulating base.

882,675. ANNOUNCING OR STATION INDICATOR FOR RAILROADS AND STREET CARS. William S. Gunter, Swedeburg, and Carrie E. Welton, Fairbury, Neb. Automatic station or destination annunciator.

882,681. ELECTROMAGNETIC TOY ENGINE. Harry G. Hawekotte and Henry W. Klausmann, Indianapolis, Ind. The reciprocating motion is secured by means of double-wound electromagnets.

882,682. COMMUTATOR FOR POLYPHASE CURRENTS. Alexander Heyland, Brussels, Belgium. The commutator is provided with electrically insulated sections.

882,687. ELECTRICAL CONTROL SYSTEM. Henry D. James, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. An under-load circuit-breaker and reversing switch.

882,695. SYSTEM FOR AUTOMATICALLY STOPPING CARS OR TRAINS. Edward E. Kleinschmidt, New York, N. Y., assignor to George M. Seeley, New York. A track electromagnet combined with a signal and normally open circuit.

882,699. ELECTRICAL RECEPTACLE FOR PLANTS. Harry S. Latshaw, Jersey Shore, Pa. A receptacle comprising a combination of negative and positive elements in the body.

882,717. COMBINED TROLLEY WHEEL AND SLEET CUTTER. Edmund M. Schollenberger, Chicago, Ill., assignor of one-half to August C. Berwanger, Chicago, Ill. The axle is provided with adjustable members for gripping the conductor wire.

882,733. ELECTRIC FURNACE. Edwin Appleby, Chicago, Ill. As the charge is accumulated the receptacle may be drawn away from proximity with the electrodes.

882,744. SIGNALING DEVICE. Spencer C. Cart, Spokane, Wash. A combination of a visual, audible and tell-tale signal device.

882,752. LETTER-BOX ALARM AND INDICATOR. Oscar F. Erickson, Berkeley, and Richard H. Bradshaw, Oakland, Cal. The entrance to the letter-box closes an alarm and indicator circuit.

882,753. TROLLEY WHEEL. Daniel D. Grant, Pittsfield, Mass. The wheel is provided with countersunk portions for renewal.

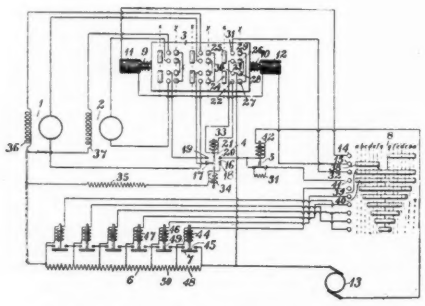
882,758. FIRE-ALARM SYSTEM. Henry H. Hillier, Pasadena, Cal. A combination of an alarm circuit and annunciator system.

882,788. ELECTRIC FURNACE. Albert L. Marsh, Lake Bluff, Ill., assignor to Hoskins Company, Chicago, Ill. The furnace lining forms a variable-resistance rheostat.

882,802. SAFETY INDICATOR FOR RAILWAYS. Oscar Stankey and Martin Christ, East St. Louis, Ill. A visual color signal for railway safety indication.

882,803. INSULATOR. Leonard W. Storror, San Francisco, Cal. A two-part insulator.

882,848. SNAP SWITCH. William M. Scott and James H. Wyatt, Philadelphia, Pa.; said Wyatt assignor to said Scott. A quick-break switch with an independent locking member.



882,687.—Electrical Control System.

882,850. LINEMAN'S PORTABLE TELEGRAPH AND TELEPHONE POLE SEAT. Charles T. Troell, Seguin, Tex. Clamp bars automatically secure the seat to the pole.

882,857. SIGN. Edgar B. Wolfe, Newark, N. J., assignor to the Electric Motor and Equipment Company, Newark, N. J. A unit letter electric sign.

882,872. SYSTEM OF ELECTRICAL DISTRIBUTION. Rufus N. Chamberlain, Depew, N. Y., assignor to Gould Storage Battery Company. A multivoltage, counter-electromotive-force system of potential control.

882,892. ELECTRICAL PROTECTIVE APPARATUS. James A. Kenny, Chicago, Ill. A corrugated carbon air-gap arrester.

882,946. STARTING DEVICE FOR MOTORS. Maxence J. S. A. Isnard, Grenoble, France, assignor to Paul Drevet and Louis Augustin Nove-Josserand, Lyon, France, and Noel Dumond, Tassin la Demi-Lune, near Lyon, France. A pneumatic spring-opposed rack-and-pinion piston.

882,966. TROLLEY. Henry C. Reynolds, Portersville, Cal., assignor of one-half to Albert J. De Laney, Portersville, Cal. The harp is permitted movement through pinion and gear segment on the pole.

882,979. STRAIN INSULATOR. William C. Terry, Boston, Mass., assignor, by mesne assignments, to the Macallen Company, Boston, Mass. The insulator is provided with a self-attaching lug.

882,990. RESISTANCE UNIT. Lawrence E. Barringer, Schenectady, N. Y., assignor to General Electric Company. A fused rare-earth resistance member.

883,007. ALTERNATING-CURRENT REGULATOR. Augustine R. Everest, Rugby, England, assignor to General Electric Company. A core leg enclosed in a suitable casing and provided with a rocker shaft and counterweight.

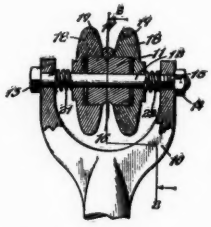
883,008. THERMOSTAT. Charles J. Fox, London, England. A U-shaped metal frame holding a strip of metal arranged to sag downward and close a circuit.

883,030. VAPOR ELECTRIC APPARATUS. Osias O. Kruh, Schenectady, N. Y., assignor to General Electric Company. A phase-converter and current-rectifying device.

883,043. DYNAMOELECTRIC MACHINE. John P. Nikonow, Pittsburg, Pa. The poles are magnetically insulated from the field frame.

883,059. ELECTRICALLY OPERATED SWITCH. Henry F. Starrett, Milwaukee, Wis., assignor to the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. A solenoid-controlled, double-contact circuit-breaker.

883,078. CONTROLLER FOR ELECTRIC MOTORS. Thomas E. Barnum, Milwaukee, Wis., assignor to the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. An electromagnet and lever arm provide means for automatically stopping a motor at predetermined periods.



882,717.—Combined Trolley Wheel and Sleet Cutter.

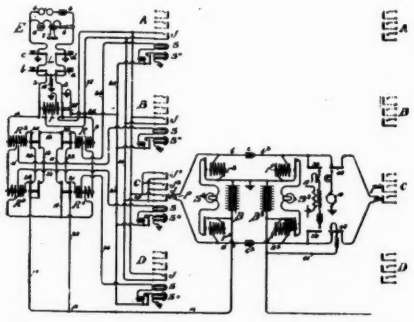
883,088. TELEPHONE INSTRUMENT. Clifford E. Cole, Birmingham, Ala., assignor of one-half to Sarah A. White, Birmingham, Ala. Means for rendering the movement of the diaphragm inoperative.

883,089. RAIL JOINT. Frank A. Collier, Galveston, Tex. A molded rail-bond section providing means for through-bolting.

883,092. CONDUIT CONSTRUCTION. William P. Day, Altoona, Pa. The abutting ends are formed with lips and recesses for end-to-end laying.

883,093. DIVIDED-CENTRAL TELEPHONE SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A central-energy intercommunicating switchboard.

883,110. ELECTRIC FURNACE. Herman L. Hartenstein, Constantine, Mich., assignor, by mesne assignments, to Continental Investment Company, Duluth, Minn. Yielding connections are provided between the electrodes.



883,093.—Divided-Central Telephone System.

883,114. VAPOR ELECTRIC APPARATUS. Osias O. Kruh, Schenectady, N. Y., assignor to General Electric Company. Shields are placed about the electrodes for changing the direction of the arc stream.

883,140. PROCESS OF ELECTROLYZING AQUEOUS SOLUTIONS OF STANNIC CHLORID. Franz von Kügelgen, Holcombs Rock, Va., and George O. Seward, New York, N. Y. A diaphragm cell combines the stannic hydroxide and hydrochloric acid.

883,141. PROCESS OF ELECTROLYZING AQUEOUS STANNIC-CHLORID SOLUTIONS. Franz von Kügelgen, Holcombs Rock, Va., and George O. Seward, New York, N. Y. The tin chloride is added to the anode solution and the electric current reversed after passing through the hydrochloric acid anode solution and tin chloride cathode solution.

883,150. ACTUATING MECHANISM FOR ELECTRIC SWITCHES. Harry B. Snell, Toledo, Ohio, assignor to the Snell-Judd Company. A step-by-step clock-controlled actuating mechanism.